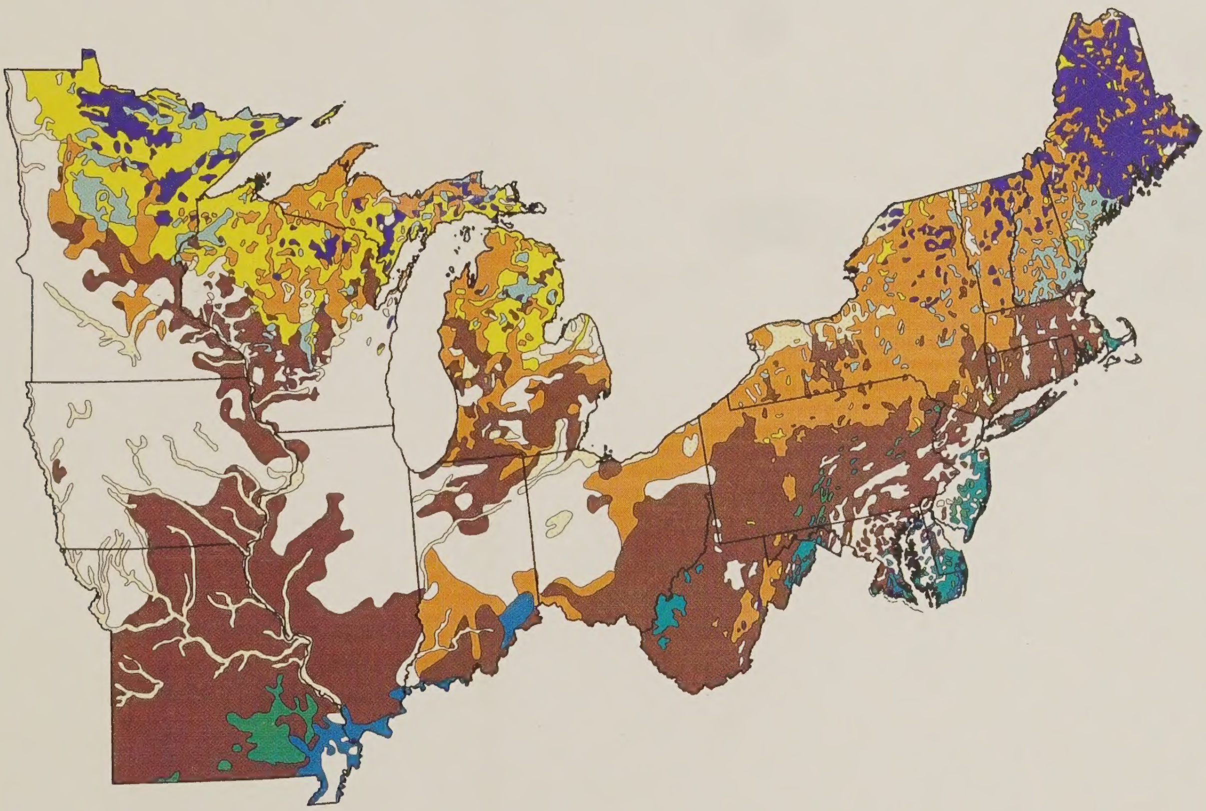
United States
Department of
Agriculture

Forest Service

Northeastern Area

NA-TP-03-93

Northeastern Area Forest Health Report



Northeastern Area
Forest Health Report

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Preface

The National Forest Health Monitoring Program is focusing on assessing the condition of our nation's forests in response to the interests and concerns of the American people. As a part of the program, this report was produced in an effort to present information about forest condition and forest stressors (insects, pathogens, weather, fire, and air quality) with respect to major forest types. This document provides an historical perspective on the influence of the various forest stressors and assesses recent impact, through 1991, on the forests within the 20 States that comprise the Northeastern Area of the USDA Forest Service. Through these annual reports, we hope to be able to identify factors that may be affecting forest condition within this area.

Highlights

The Northeastern Area is comprised of 20 states covering 413.9 million acres, of which 40 percent is forested. About 93 percent of the forested acreage is land considered available for production of wood products, with the remaining being in wilderness, natural areas, urban forests, and parks.

The forests within the Northeastern Area have undergone considerable change over the last three centuries. By the beginning of the 20th century, most all of the eastern forests had been cut-over and many acres burned. Abandoned and protected areas were often reclaimed by trees, and this reforestation resulted in a forest that frequently was different from the original. A great variety of tree species now occupy the landscape.

North American forests have been affected by the introduction of forest pests from Europe and Asia. Chestnut blight, Dutch elm disease, white pine blister rust, beech bark disease, and gypsy moth have, in some cases, virtually eliminated significant components of the original forest and have permanently changed the composition and health of today's forest.

Information has been collected concerning the impact of various forest stressors on the nine major forest type groups which occur in the Northeastern Area:

white-red-jack pine	spruce-fir	hard pine
oak-pine	oak-hickory	oak-gum-cypress
elm-ash-cottonwood	maple-beech-birch	aspen-birch

In general, this report finds that pest activity is not uniformly threatening any forest in the Northeastern Area. However, there are concerns over several pest problems, in both natural and urban forested areas. These pests mostly affect individual tree species within the forest. Nevertheless, their importance is magnified by their potential impact upon these species. The more notable pest problems include:

- Gypsy moth defoliation, causing oak decline and mortality in the oak-hickory forests and in forested residential communities.

- Beech bark disease, causing extensive mortality to American beech.

- Butternut canker, causing widespread loss of the butternut in oak-hickory and maple-beech-birch forests.

- Dutch elm disease, continuing to cause mortality of American elms.

- Chestnut blight, which practically eliminated and continues to affect the American Chestnut throughout its range.

- Dogwood anthracnose, causing serious losses throughout the range of this important understory and ornamental tree species.

- Eastern hemlock looper and hemlock woolly adelgid, affecting forest and ornamental hemlock.

- White pine blister rust and white pine weevil, limiting eastern white pine planting.

Abiotic factors are also of concern, including ozone damage on sensitive species such as eastern white pine, effects of acidic deposition on the high-elevation red spruce resource, drought-caused tree mortality (particularly in the Lake States), and fire associated with drought and insect defoliation.

The affects of all of these pests and stressors, and their interactions, need to be continually monitored to determine the relative health of the forests in the Northeastern Area.

Introduction

Historical Perspective

The forests of the United States have undergone considerable change over the last 130 years (Figure 1). Since arriving on this continent, humans have affected the forest environment. Wood was the most abundant natural resource available to satisfy the needs of growing communities. Large tracts of land were logged to make way for towns and agriculture. Fire, which has always been a natural component of the forest ecosystem, regularly accompanied logging and became even more frequent with the advent of the wood-burning locomotive. By the beginning of the 20th century, most all of the eastern forests had been cut over and many acres burned.

As people emigrated westward to new frontiers, abandoned and protected areas were often reclaimed by trees. This reforestation resulted in a forest that was frequently different from the original. Pioneer forest species became established in place of longer-lived climax species. Many of the great conifers were replaced by hardwood species, and many large tracts of pine, spruce, and fir were eliminated. This "new forest" is the one that we see today. A great variety of tree species now occupy the landscape. Theseforests were created as a result of human activity and intervention.

North American forests have also been affected by the introduction of forest pests from Europe and Asia. Chestnut blight, Dutch elm disease, white pine blister rust, beech bark disease, and gypsy moth have, in some cases, virtually eliminated significant components of the original forest and have permanently changed the composition and health of today's forest.

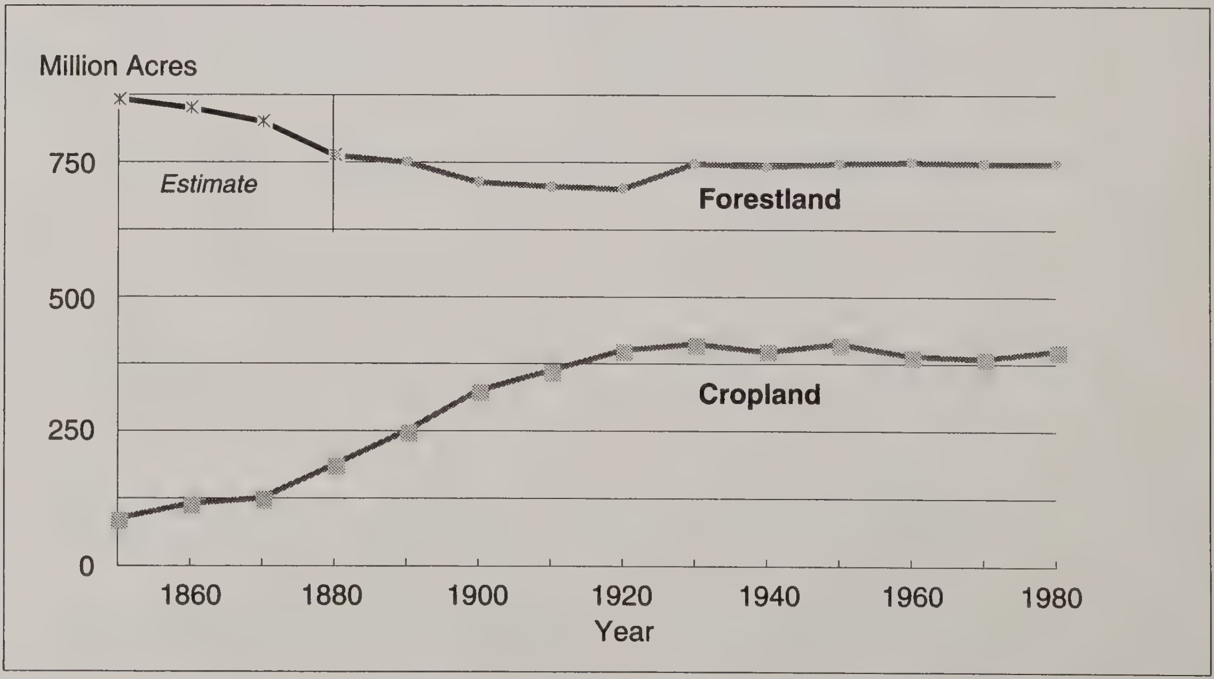


Figure 1. U.S. Crop and Forest Land Area, 1850 - 1980 (Adapted from Waddell et al. 1989).

Defining Forest Condition

Forests have always been subject to forces in the natural environment and exist because of their capability to respond to these stressors. Drought, fire, forest succession, and forest insects and micro-organisms have always shaped the extent and character of forests. Increasingly, human-caused factors, such as newly introduced pests, air pollution, and the possible effects of changes in global climate, are influencing forests and have focused attention on how society can best sustain the health of today's forests.

It is difficult to assess the general health of forests at any point in time since they are dynamic systems undergoing continuous change. Forest health can be defined as the ability of a forest to recover from natural and human-caused stressors. Some traditional measures of forest health are: the age and composition of the forest; trends in tree growth and mortality; condition of tree crowns; condition of soil, water, and wildlife; frequency and severity of pest outbreaks; and a forest's vulnerability to pests.
Over time, single or multiple stressors may alter trees to a point where they can no longer recover and begin to "decline", exhibiting crown dieback and deterioration. This decline may be reflected by changes in rates of succession, forest composition and structure, or general productivity. Large outbreaks of insects and diseases do not automatically indicate a deterioration in forest health. The frequency and intensity of outbreaks of native pests reflect normal ecosystem dynamics. However, combinations of stressors, such as prolonged drought and insect defoliation, cause tree energy to be sapped. It is desirable to establish and maintain forests that are as resilient as possible to natural and human-caused stressors, while meeting the values, needs, and expectations of society.

The Forest Resource

The Northeastern Area is comprised of 20 states, covering 413.9 million acres, of which 40 percent is forested (Figure 2, Table 2 - Appendix II). About 93 percent of the forested acreage is land considered available for the production of wood products, with the remaining being in wilderness, natural areas, urban forests, and parks.

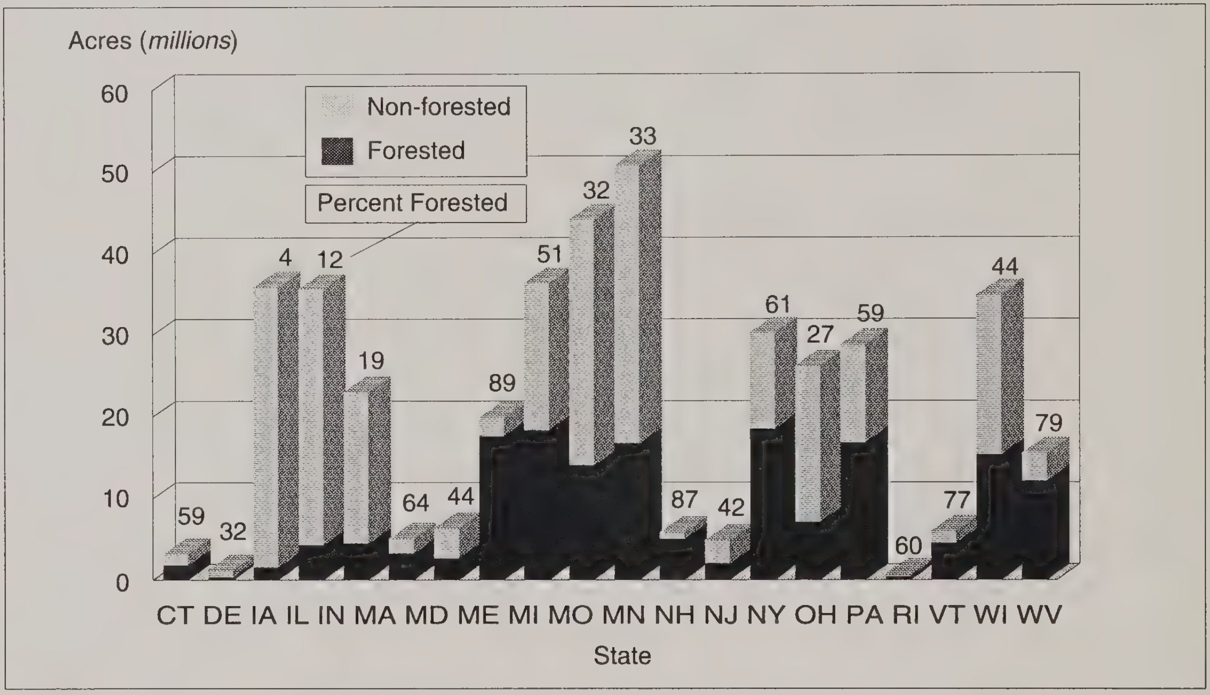


Figure 2. *Land Area by State, Forested and Non-Forested Acres (Data used for this graph in Table 2 - Appendix II).*

The forest resource contains various tree species which can be found in pure stands or in association with other tree species. Forest type is a classification of forest land based on the tree species growing on the land. The forest types are described by the Society of American Foresters in *Forest Cover Types of the United States and Canada* and are named after the predominant tree species. The occurrence of a forest type in a particular area is dependent on soil characteristics and climate. The species composition of a stand varies according to past history, use, and current growing conditions. Forest types may change due to disturbance or natural succession to other forest species.

The many forest types which occur in the Northeastern Area are combined by the USDA Forest Service, Forest Inventory and Analysis Unit, into nine major forest type groups. These groups are: **white-red-jack pine, spruce-fir, hard pine, oak-pine, oak-hickory, oak-gum-cypress, elm-ash-cottonwood, maple-beech-birch, and aspen-birch** (Figures 3 and 4, Table 3 - Appendix II). The specific stressors that affect these forests and urban forested land are discussed in this section.

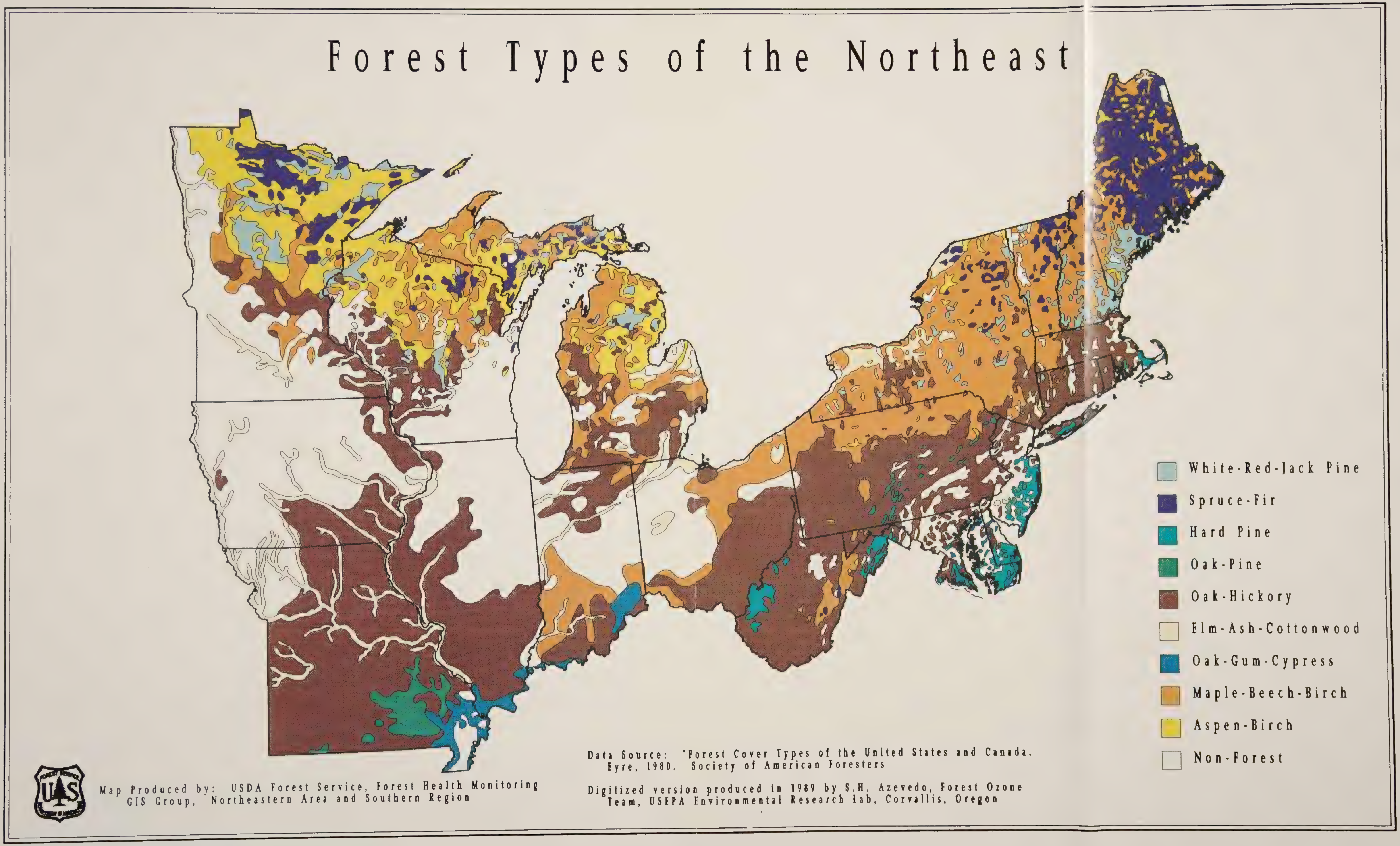


Figure 3. Forest type distribution in the Northeastern Area

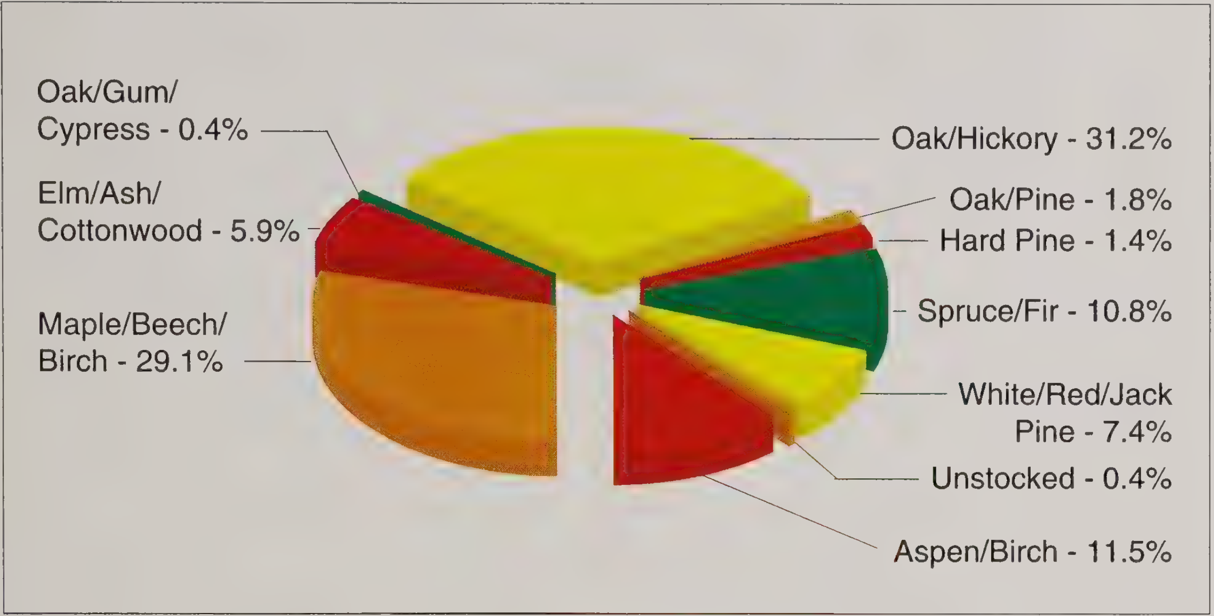


Figure 4. *Timberland Distribution by Forest Type Group in the Northeastern Area.*

Forest Type Groups

White-Red-Jack Pine Forest

White, red, and jack pine frequently overlap within the white-red-jack pine forest. One of these species tends to predominate, depending on soil fertility and soil moisture. On some sites, eastern white pine is much more prevalent than on other sites where red pine is more successful. Jack pine often occurs in pure stands in areas where fire has exposed mineral soils and on dry, sandy, or gravelly soils. Eastern hemlock is a common associate of eastern white pine, and their ranges closely coincide; although eastern hemlock does not extend as far west and north as eastern white pine. Since each of these species has distinctive ecological requirements and is usually managed in a unique way, they are discussed separately.

Eastern White Pine

Eastern white pine is found throughout the Northeastern Area. It occurs in pure stands and commonly with other species, such as eastern hemlock, chestnut oak, red maple, and northern red oak. Eastern white pine occurs on a wide range of soil types from coarse, droughty soils to moist sites and is found in association with the maple-beech-birch, aspen-birch, spruce-fir, red pine, and jack pine forests.

Eastern white pine is the largest of the conifers that occur in the Northeastern Area. It commonly grows to 100 feet in height and 3.5 feet in diameter. Trees as old as 450 years have been reported.

Eastern white pine is affected by many factors, such as the white pine weevil, various needle diseases, trunk and root rots, excessive salt spray, and certain individual trees are especially susceptible to ozone air pollution injury. However, the most serious threat to the health of eastern white pine is white pine blister rust. White pine blister rust was first found in Geneva, NY in 1906 and, by 1960, was present throughout the range of eastern white pine. This disease infects and kills trees of all ages throughout the range of eastern white pine. In an attempt to control infection, an extensive effort was made in the mid-1900's to eradicate currant and gooseberry bushes, which are alternate hosts for the disease. In 1991, blister rust, white pine weevil, and deer browsing continue to be the major limiting factors in the culture of this important timber species. Eastern white pine was also affected by defoliation from the introduced pine sawfly, which occurred on approximately 15,000 acres in Wisconsin and was scattered in northern Minnesota.

Red Pine

Red pine occurs in the Lake States, New England, New York, and Pennsylvania, with two-thirds of the area in the Lake States. It occurs naturally in pure stands or in a mixture with northern pin oak, eastern white pine, or jack pine. Red pine has also been planted extensively. It is most common on sandy, well-drained soils. On some sites, red pine may be found with red maple, northern red oak, white spruce, and balsam fir. Red pine will often succeed less shade-tolerant jack pine, paper birch, and aspens and be replaced by eastern white pine, white spruce, and balsam fir, which regenerate more readily in the understory.

In the Lake States in 1990, over 137,000 red pine trees were cut for use as poles, pilings, and in the construction of log cabin homes. The value of the raw material was over $20,000,000.

Red pine is susceptible to various insects and diseases, especially scleroderris canker, red pine scale, red pine adelgid, and pine sawflies. The red pine scale and red pine adelgid, both introduced pests, are causing mortality of trees of all ages in southern New England and southeastern New York; and their range is expanding out from the infested area. Scleroderris canker disease has been found in scattered locations in the Lake States, northern New England, and New York. It was a major concern in the 1970's, when there was a dramatic increase in the area of infection due to weather conditions. The incidence of infection has declined since. A state quarantine, which restricts movement of infected trees, is still in effect in northern Vermont. This effort is being made to protect the valuable Christmas tree industry in the southern portion of the state and neighboring states.

The European pine sawfly is a common defoliator of red pine, often in young plantations. Repeated defoliation can cause growth reductions and mortality. Light defoliation, caused by this insect, occurred in small areas of Indiana. The red pine beetle commonly causes scattered mortality when red pine is subjected to other stressors, such as drought or a recent blowdown. Red pine that is planted outside their natural range is often attacked. In 1991, scattered mortality by red pine beetle was reported at one location in the Upper Peninsula of Michigan. Most notable, previous years of drought resulted in scattered mortality throughout the range of red pine.

Jack Pine

Jack pine occurs throughout the Lake States and sporadically in northern New England and northern New York. It is often found in pure stands, but commonly includes other species. Associated species are oaks, aspen, white and red pine, eastern larch, spruce, and fir. Jack pine is a short-lived, shade-intolerant species. It often originates after forest fires, which kill competitive species, prepare the seed bed, and release seed from cones. Without repeated disturbance by forest fire, jack pine is replaced by more shade-tolerant species, such as eastern white pine, red pine, and maple-beech-birch or spruce-fir forests.

The Kirtland warbler is an endangered species that requires jack pine forests for its habitat. The warbler needs homogeneous jack pine stands of at least 80 acres that are 5 to 20 feet in height for reproduction. The National Forests in the northern sections of the Lower Peninsula of Michigan have developed management plans to provide this habitat for the Kirtland's warbler.

Defoliating insects, such as the jack pine budworm, jack pine sawfly, and the redheaded jack pine sawfly, cause varying degrees of growth reduction, dieback, and mortality during occasional population outbreaks. Outbreaks of the jack pine budworm occur in cycles. Moderate to heavy defoliation occurs for 2 to 3 years, followed by 6 to 10 years of no detectable feeding. Defoliation results in needle loss, top kill, and in some instances, mortailty of the entire stand. In the 1970's and 1980's, the Lake States sustained heavy losses in older stands on droughty soils. In 1991, jack pine budworm defoliated more than one-half million acres in the northern Lower Peninsula of Michigan, approximately 50,000 acres in the Upper Peninsula, and scattered defoliation in northern Minnesota. Areas were defoliated by the jack pine sawfly in northern Minnesota and the redheaded jack pine sawfly in Wisconsin.

Eastern Hemlock

Eastern hemlock ranges from northern New England, west to Minnesota and south through the Appalachian Mountains. It occurs in pure stands, or is commonly associated with eastern white pine, balsam fir, red spruce, sugar maple, American beech, yellow-poplar, and yellow birch. Eastern hemlock grows best on moist, well-drained sites, but also grows in wet, almost swampy areas or sandy streambanks. Unlike eastern white pine, eastern hemlock is very shade-tolerant and can endure decades of suppression, but does not tolerate dry conditions.

***Figure 5**. Hemlock Woolly Adelgid (Photo: Mark McClure, Connecticut Agricultural Station)*

Eastern hemlock is seldom affected by diseases. However, it can decline rapidly when suddenly exposed after cutting, and it is affected by several insect pests. Currently, the most important insects attacking eastern hemlock are the hemlock looper, a related looper, and the hemlock woolly adelgid (Figure 5). The loopers prefer to feed on eastern hemlock, balsam fir, and white spruce. Outbreaks usually occur every 20-30 years. Populations of the hemlock looper began to increase in Maine three years ago. The infestation has spread over 325,000 acres, causing moderate to heavy defoliation and greater than 50 percent mortality in some areas (Figure 6). Populations have increased dramatically in Vermont, but no detectable defoliation has occurred. Defoliation of eastern hemlock from a related looper occurred to a much smaller extent in Connecticut, Massachusetts, New Hampshire, Maine, and southern Vermont.

The hemlock woolly adelgid was introduced into the Unites States in the early 1900's and was first reported in the eastern United States in 1953. It is a serious pest on eastern hemlock (and Carolina hemlock in the south) in both forested and urban areas. In some locations, the elongate hemlock scale is found in conjunction with the hemlock woolly adelgid. Recently, the adelgid has been reported damaging eastern hemlock from southern New England and New York to New Jersey, Pennsylvania, Maryland, and West Virginia (Figure 7). Infestations are expected to spread, and mortality is expected to increase. The adelgid was introduced to Vermont on nursery stock in 1990. The nursery stock was destroyed and no evidence of the pest has been found in native stands.

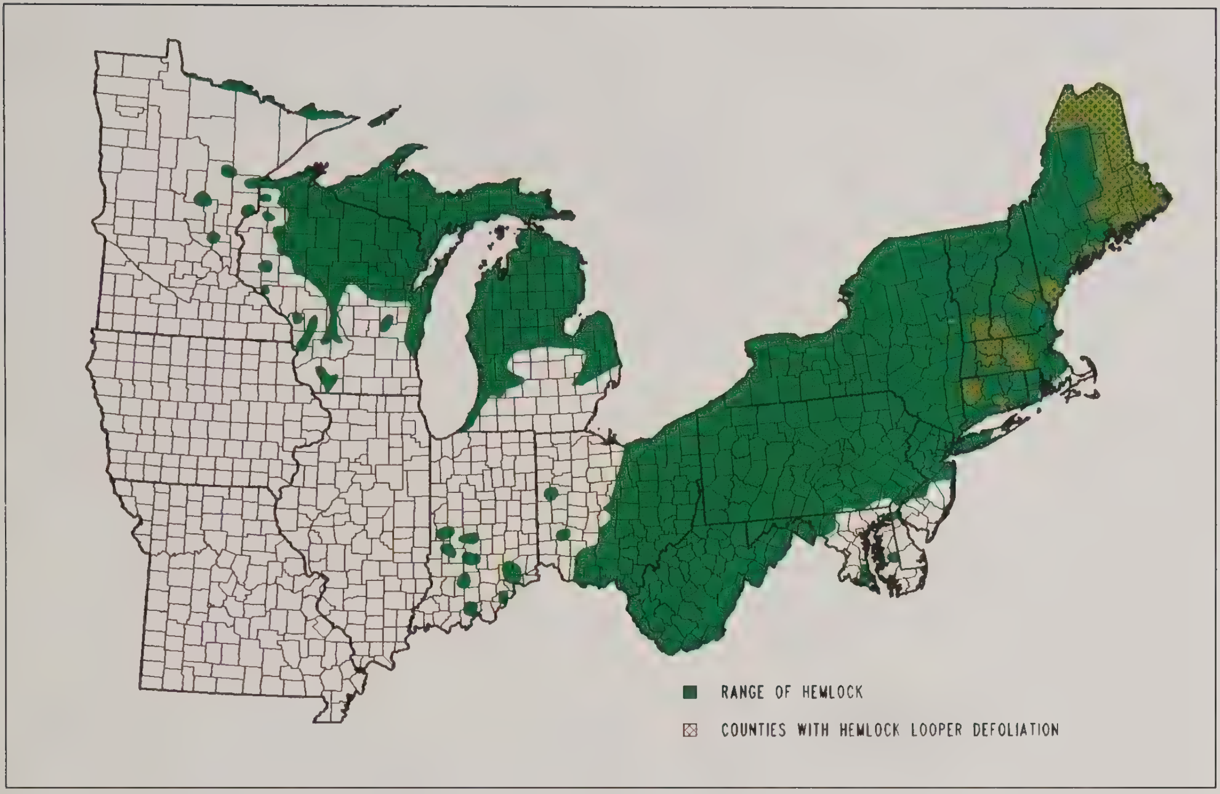


Figure 6. *Hemlock Looper Defoliation, 1991 (Map produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

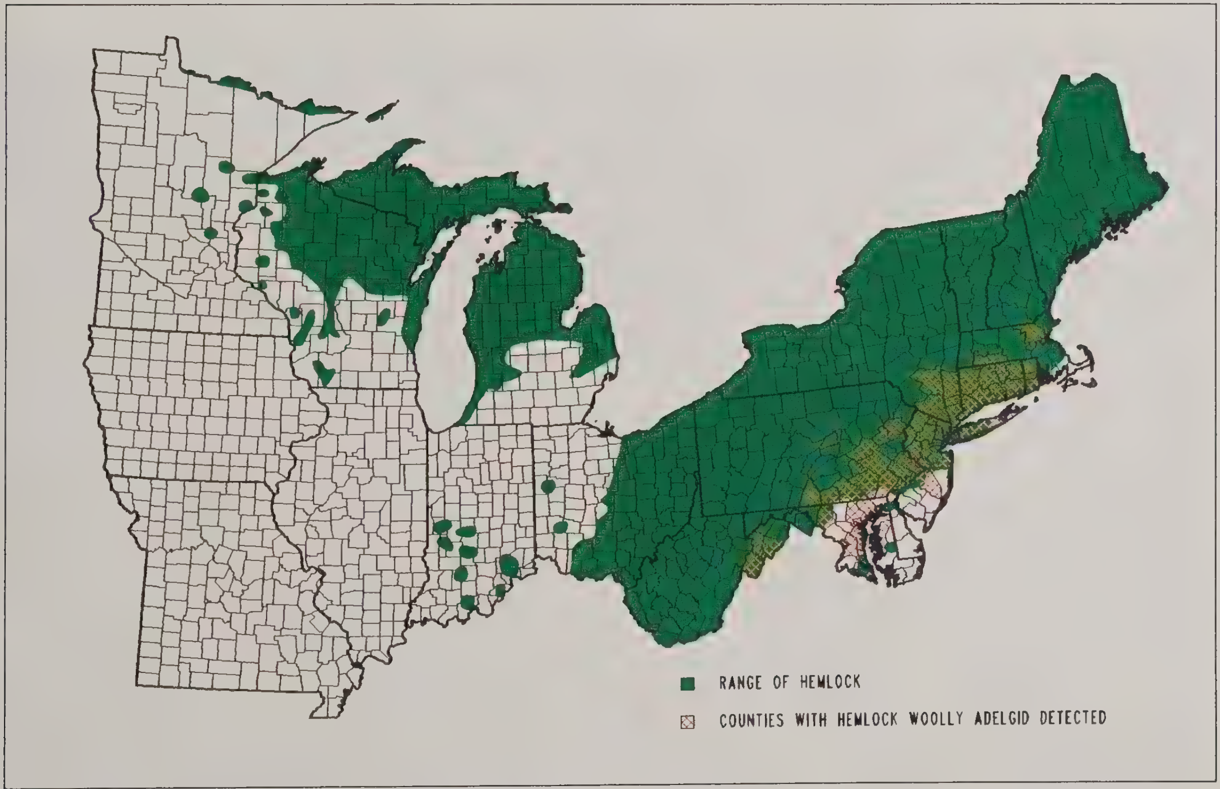
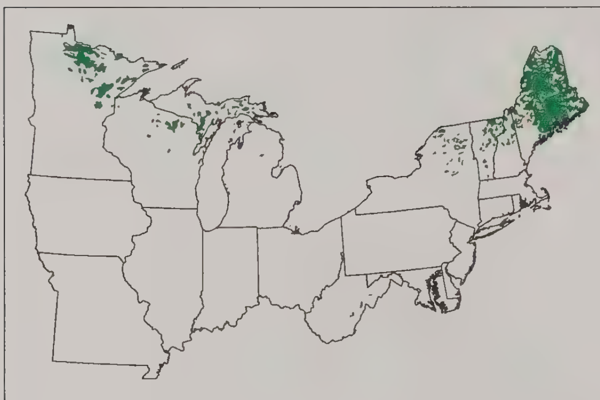


Figure 7. *Hemlock Woolly Adelgid Distribution, 1991 (Map produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

Spruce-Fir Forest



There are about 16.8 million acres of spruce-fir forest in the Northeastern Area, found mostly in the northern regions of New England and the Lake States. About half of the area is in Maine, one-fifth in Minnesota, and the remaining in Wisconsin, Michigan, New York, New Hampshire, Vermont, Pennsylvania, Massachusetts, and Connecticut. Red spruce is also found in West Virginia at higher elevations. The spruce-fir forest is comprised mostly of red spruce, black spruce, white spruce, balsam fir, eastern larch, and northern white-cedar (with Fraser fir a component in the North Carolina, Tennessee, and Virginia) (Figure 8). On some sites eastern white pine, red maple, yellow birch, paper birch, aspen, eastern hemlock, and sugar maple intermingle with the spruce and fir.

Spruce-fir forests are typically found on the poorer growing sites with cold temperatures and thin, poorly-drained, acid soils. Heavy logging occurred in the late 1800's and early 1900's and continues today in some areas, especially northern Maine. Land clearing and slash fires following logging were frequent and widespread. The combination of agriculture, logging, and fires is probably responsible for the conversion of prime growing sites to maple-beech-birch forest.

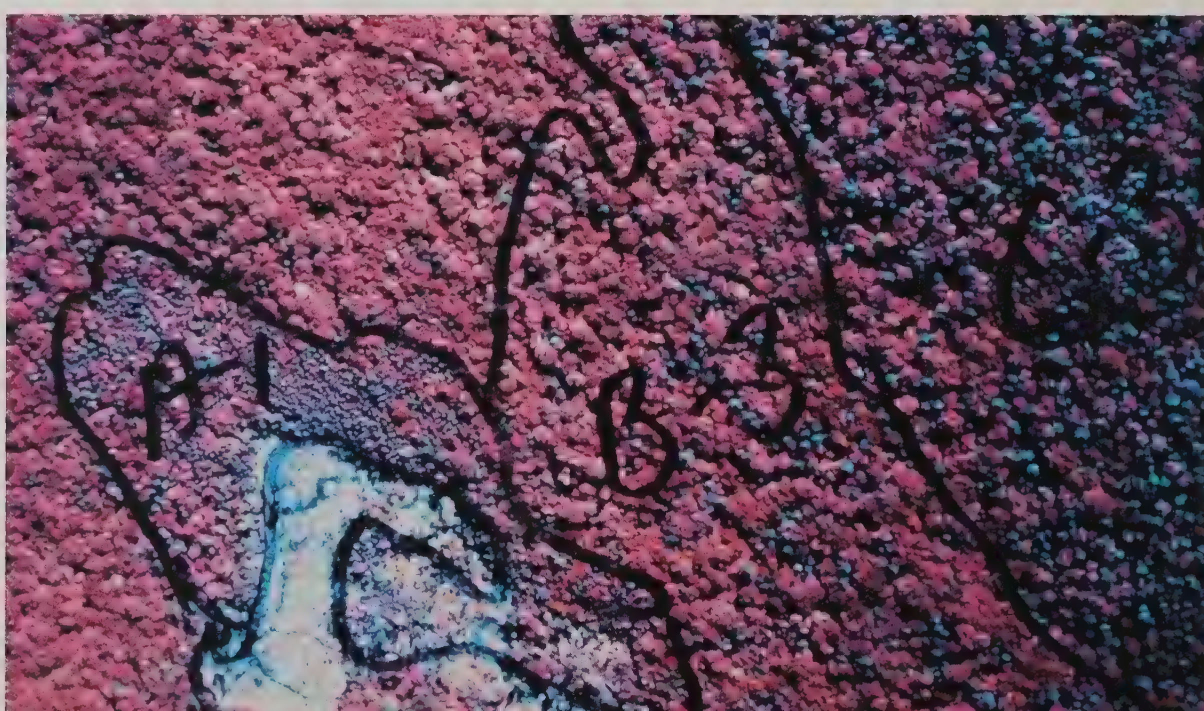


Figure 8. *Color Infared Photo of Spruce-Fir Conditions. A-1, Spruce-Fir Swamp; B-3, Mixed Hardwood and Spruce-Fir; C-3, Spruce-Fir Stand. (Photo: USDA Forest Service).*

The most historically important and damaging pest has been the spruce budworm, which prefers to feed upon balsam fir, red spruce, and white spruce, but will also defoliate black spruce. Major outbreaks occur every 40-50 years, with the last occurring in the late 1970's and early 1980's (Figure 9). In 1991, the only visible spruce budworm defoliation in the Northeastern Area occurred on about 100,000 acres in northern Minnesota (Figure 10). Spruce budworm populations, which are monitored by trapping of male moths, increased in New York and northern Vermont, but no defoliation was detected. Population levels in Maine continue to be low. Stillwell's syndrome, tree mortality associated with spruce budworm defoliation and Armillaria root disease, is affecting balsam fir in Maine.

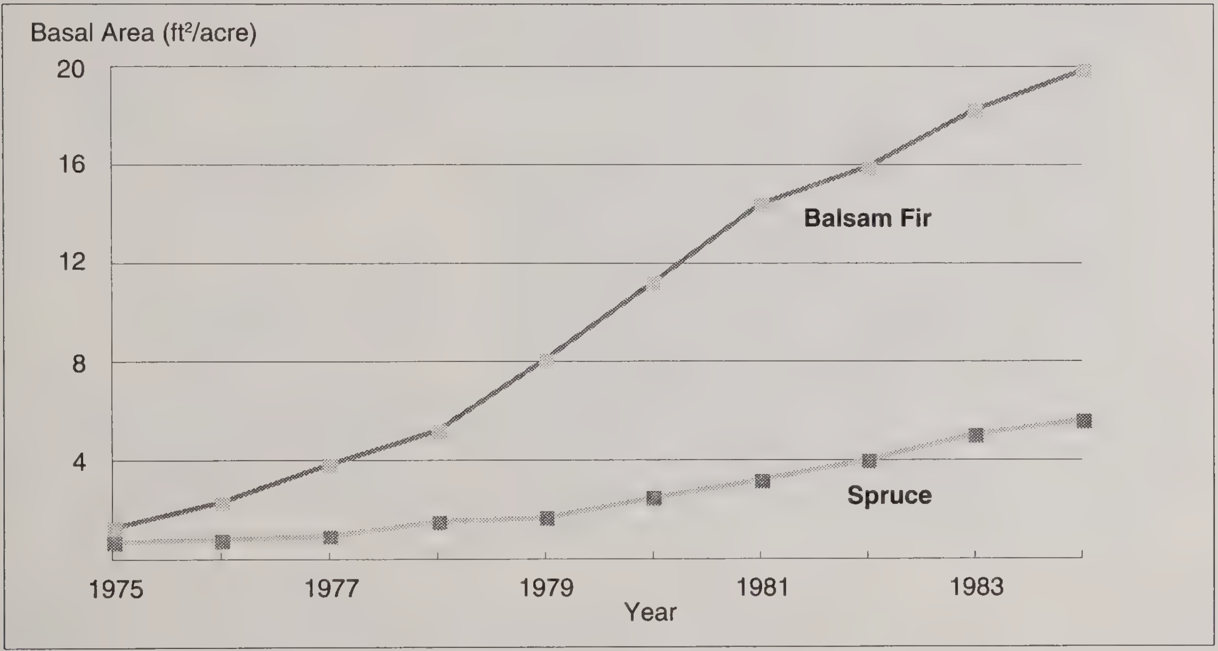


Figure 9. *Cumulative Mortality, in Basal Area, of Balsam Fir and Spruce from 1975 - 1984 (Adapted from Solomon and Brann, 1992).*

Summary of the Forest Response Program, Spruce-Fir Cooperative Results: "There is evidence that acidic cloudwater in combination with other stresses affected some high elevation spruce forests in New Hampshire, New York, and Vermont".

Another historically important pest has been the eastern spruce beetle, which attacks mostly mature red and white spruce. Vast outbreaks occurred before the 1900's, but since then only pockets of infestation and mortality have occurred. Mortality of over 25 percent occurred in concentrated areas on 9,000 acres in the northern and western areas of Maine in 1991. The outbreak has continued since the mid 1980's, mostly in areas previously defoliated by the spruce budworm, and appears to have peaked in 1990. Recently, areas of mature red spruce in the Adirondacks and northern New Hampshire were affected by an outbreak of the spruce beetle, which caused extensive mortality in some areas.

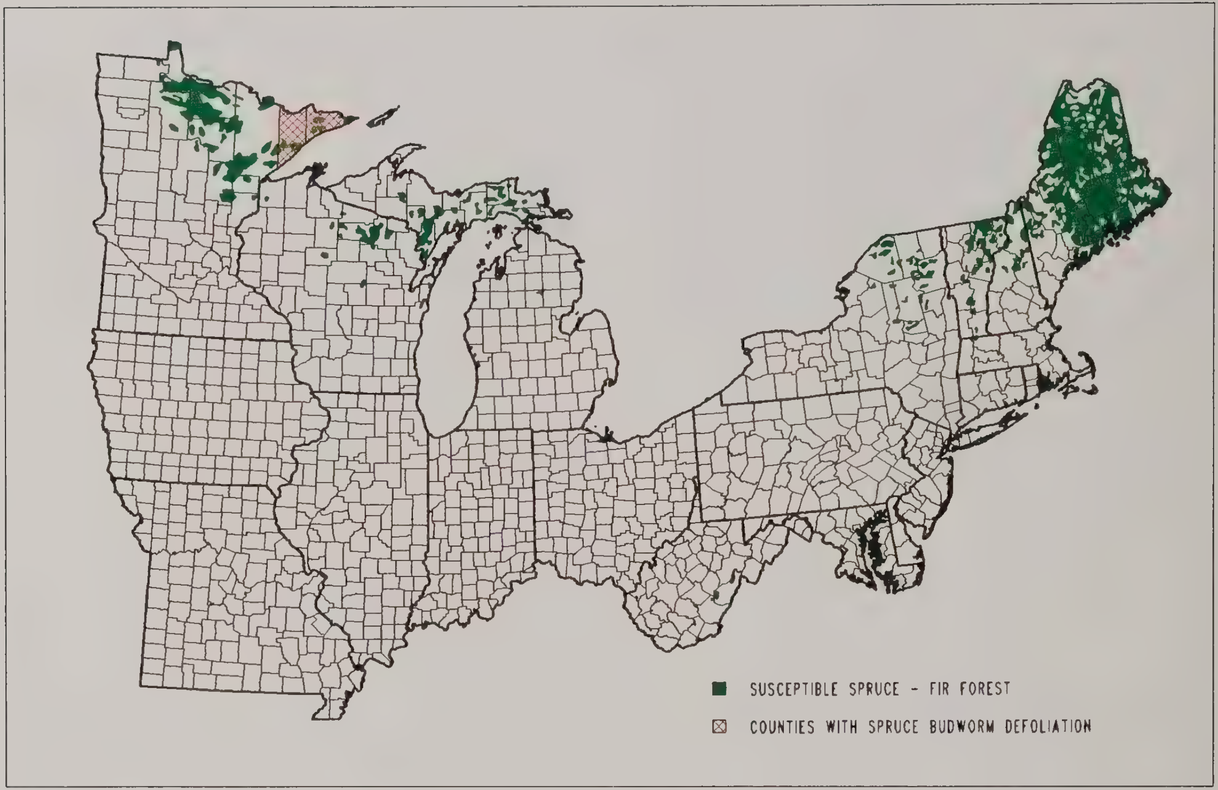


Figure 10. *Counties with Spruce Budworm Defoliation / Susceptible Spruce-Fir Forest (Map Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

A survey of red spruce and balsam fir was recently conducted, and permanent monitoring sites were established in the spruce-fir and the mixedwood/ spruce-fir forests of New Hampshire, Vermont, New York, Massachusetts, and West Virginia. These plots have been assessed for trends in visual symptoms and tree mortality since the mid 1980's. Results indicate that tree crown condition has deteriorated on some sites; however, mortality has been only around one percent per year. Damage from biotic and abiotic factors was identified at various sites. Mortality was most dramatic in areas attacked by the spruce beetle and stands exposed to chronic wind and ice damage. In addition to the ground survey, portions of New York, Vermont, New Hampshire, and western Maine were aerially photographed with color infrared photography to determine the extent and severity of spruce-fir standing dead at various elevations. Utilizing a geographic information system, areas of standing dead trees were computer mapped and analyzed (Example in Figure 11). Based on this project, it was determined that the proportion of standing dead trees was greater at the higher elevations. These surveys provide the basis for future spruce-fir condition trend surveys.

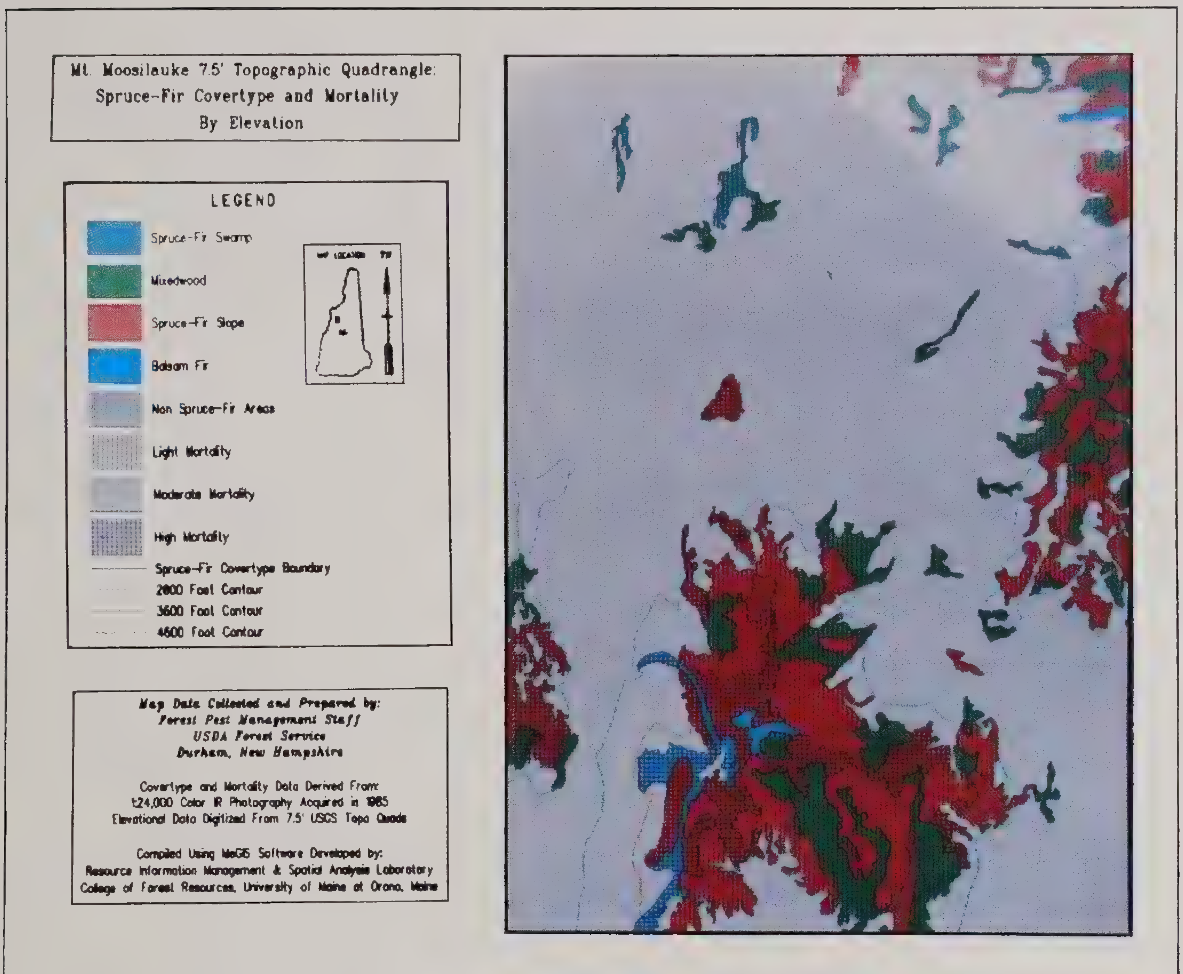
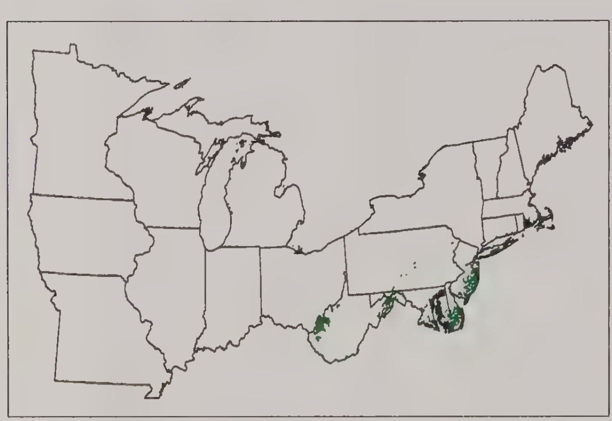


Figure 11. *Spruce-Fir Mortality Map on Mt. Moosilauke, New Hampshire.*

Eastern larch is a significant component of the spruce-fir forest. Recently, larch decline has been reported in areas in Maine and Vermont. Mortality has been common in stands infested with the eastern larch beetle. By 1991, only a few acres of mortality were mapped in Vermont; however, up to 100 percent mortality is still evident in beetle infested stands in Maine. The European larch canker, a serious disease of larch in Europe, was detected on eastern larch in coastal Maine in the early 1980's. Through surveys, it was determined the disease had been present for at least 15 years prior to detection. Currently, larch are quarantined in the infected area, and movement of material is restricted. The disease spreads slowly, but the quarantine is in effect to protect the larch resource in other parts of the United States.

Hard Pine Forest



The hard pine forest is widespread in the southern United States, but occurs only in limited areas in the Northeastern Area. The hard pine forest includes pitch pine, however, it is dominated by loblolly pine on the moister sites and shortleaf pine on the drier sites. Loblolly and shortleaf pine extend only to southern Delaware and Maryland's eastern shore. Shortleaf is also native in southern Missouri, and loblolly pine has been planted in southern portions of Missouri, Indiana, and Illinois. Scattered hardwoods may occur, especially sweetgum, blackgum, hickory, and white oak. Dogwood is a common understory tree on more open sites.

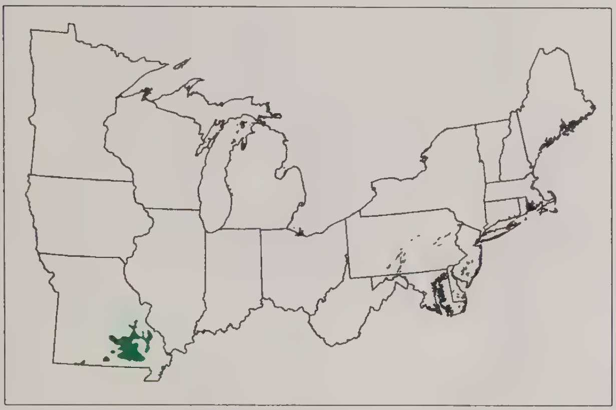
Loblolly and shortleaf pines are affected mostly by rust diseases, root diseases, and bark beetles, especially the southern pine beetle in the southeastern states. In 1991, the southern pine beetle infested 15 acres in southern Maryland. This was the first report of southern pine beetle activity in the Northeastern Area since 1987. The southern pine beetle is not considered to be a serious threat to these more northern loblolly-shortleaf forests at this time. Comandra blister rust was reported on five shortleaf pine plantations on the Mark Twain National Forest in southern Missouri.

Pitch Pine

The distribution of pitch pine is widespread but spotty. It is abundant on the outer coastal plain of New Jersey, the area known as the Pine Barrens. Pitch pine also occurs in Pennsylvania, southeastern Massachusetts, southern Maine and New Hampshire, and upstate New York. It is confined to sandy soils or ridgetops. The occurrence of pitch pine is determined by suitable sites and by past disturbances, especially fire. Pitch pine forests are remarkable in their ability to withstand fire. Trees will produce new needles, even if all the foliage is killed, and new sprouts will develop from dormant buds on the stem.

Pitch pine is a very hardy species but is susceptible to several insect pests. In 1991, an outbreak of the pine looper occurred on approximately 200,000 acres in the Pine Barrens. Defoliation within this outbreak area is severe, and some tree mortality is expected. Defoliation and needle drop, due to the defoliation, has greatly increased fire danger within the Pine Barrens. In Massachusetts, the Nantucket pine tip moth caused damage to nearly 10,000 acres of pitch pine in the Cape Cod area, and the infestation is expected to continue. The pine needleminer was also reported causing defoliation to pitch pine on approximately 4,000 acres in eastern Massachusetts.

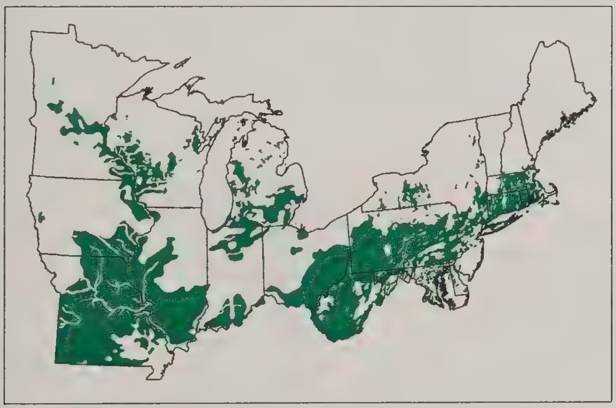
Oak-Pine Forest



The oak-pine forest extends from southern New York and New Jersey to Pennsylvania, southern Ohio, southwestern Illinois, southern Missouri, and throughout the mid-Atlantic states. It is comprised of several oak and pine species. The major oak species are white, post, black, scarlet, northern red, southern red, and chestnut oak. The pine species include eastern white, shortleaf, loblolly, Virginia, and pitch. The oak-pine forest represents a transition from an essentially pine-dominated forest to the forests dominated by oaks and other hardwoods.

Oak-pine forests have not been affected by many pest problems. In 1991, some gypsy moth defoliation occurred, however, it was not nearly to the extent as within the oak-hickory forests. The major impact may be on white pine growing under mature oaks, which are infested with the gypsy moth. In some cases, those young pine die after one year of heavy defoliation.

Oak-Hickory Forest



The largest and most diverse forest in the eastern United States is oak-hickory. It occurs from Texas, north to the Dakotas, and eastward into New England. Within the broad oak-hickory forest, various forest types are included: post oak-blackjack oak, bur oak, bear oak, northern pin oak, chestnut oak, white oak-black oak-northern red oak, white oak, black oak, and northern red oak. The great range of climate, soil, and topography results in widely different stand conditions. White oak, northern red oak, and black oak are found throughout the range. Other oaks are common on different sites. Hickories are consistent but minor components. Many understory trees and shrubs occur, such as dogwood.

The varied nature of the oak-hickory forest supports numerous insect and disease organisms. Historically, the most damaging agent to occur within the oak-hickory forest is the chestnut blight. At one time, American chestnut comprised at least 25 percent of eastern oak-hickory forests. Today, it is a minor understory component. Chestnut blight spread from an introduction in the New York City area about 1900, throughout the chestnut range, killing trees as it spread. Forests once referred to as chestnut-oak forests are now known as oak-hickory forests, since American chestnut has been

eliminated as a principal overstory component. Chestnut blight continues today to impact the oak-hickory forests. Only a few large chestnuts remain scattered throughout the region, and they are extensively infected and show various degrees of dieback. Another major pest of oak-hickory forests, and perhaps the most well known, is the gypsy moth. This defoliator has been gradually spreading south and west from its introduction in Massachusetts in 1869 (Figure 12). Although not as severe as the chestnut blight, gypsy moth has impacted some of the oak-hickory forests in New England, the mid-Atlantic states, and Michigan. The oaks, particularly black, white, and chestnut, are preferred foods of the gypsy moth and are attacked more severely than other species occurring within the oak-hickory forest. The trees are stressed and then may be attacked by the two-lined chestnut borer and Armillaria root disease.

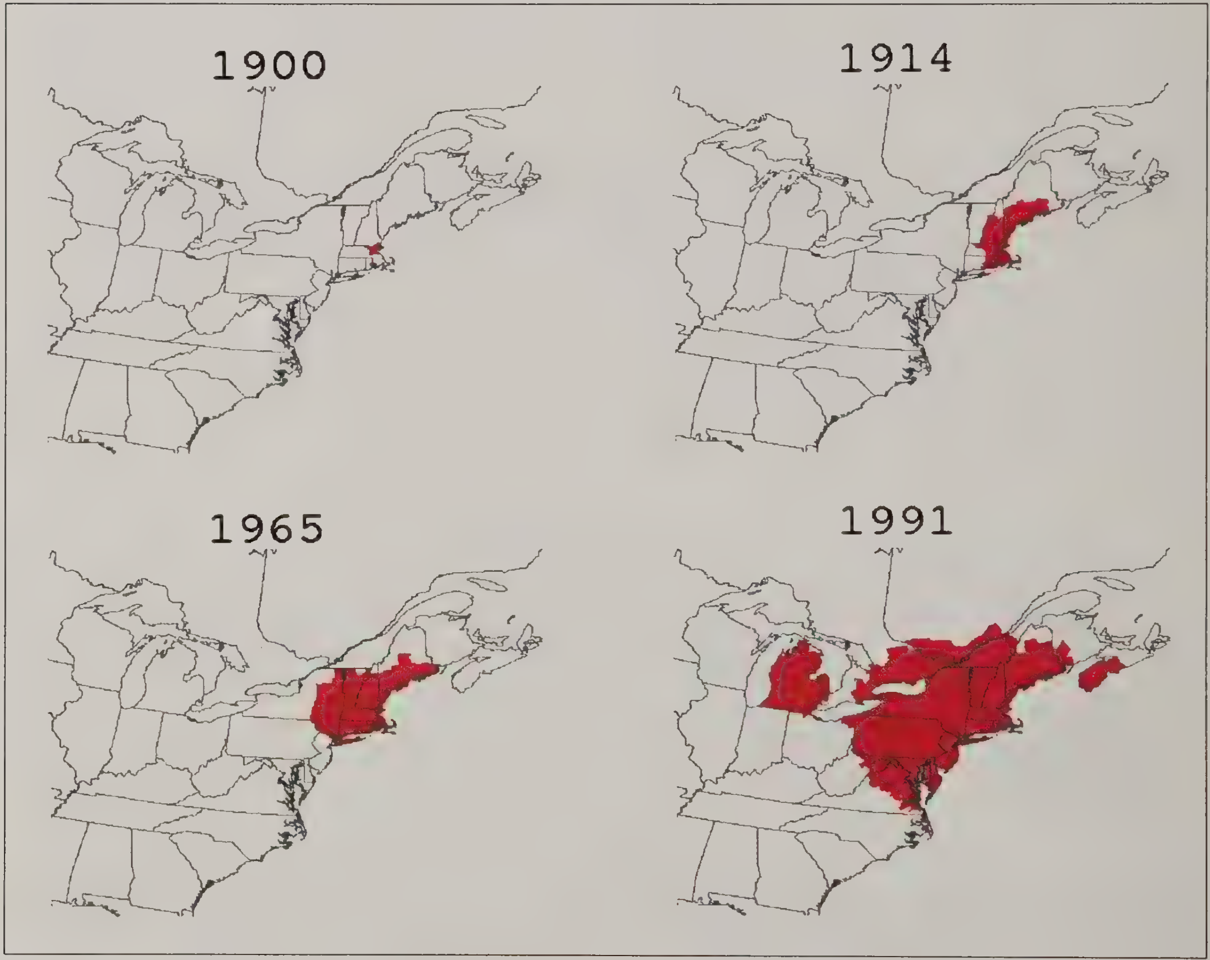


Figure 12. *Historical Maps, 1900 - 1991, of Gypsy Moth Defoliation Since its Introduction (Source: USDA - Forest Service).*

In 1991, over 4 million acres were defoliated by the gypsy moth, with most of this occurring in the oak-hickory forest (Figure 13). There are an estimated 125 million acres of susceptible forest in the area considered to be generally infested with the gypsy moth (Table 1). This includes acres of maple-beech-birch and oak-pine forest, although the gypsy moth is primarily a problem within the oak-hickory forest. Large acreages of land are sprayed annually to maintain tree health and vigor. Most of this treatment occurs within urban and residential areas.

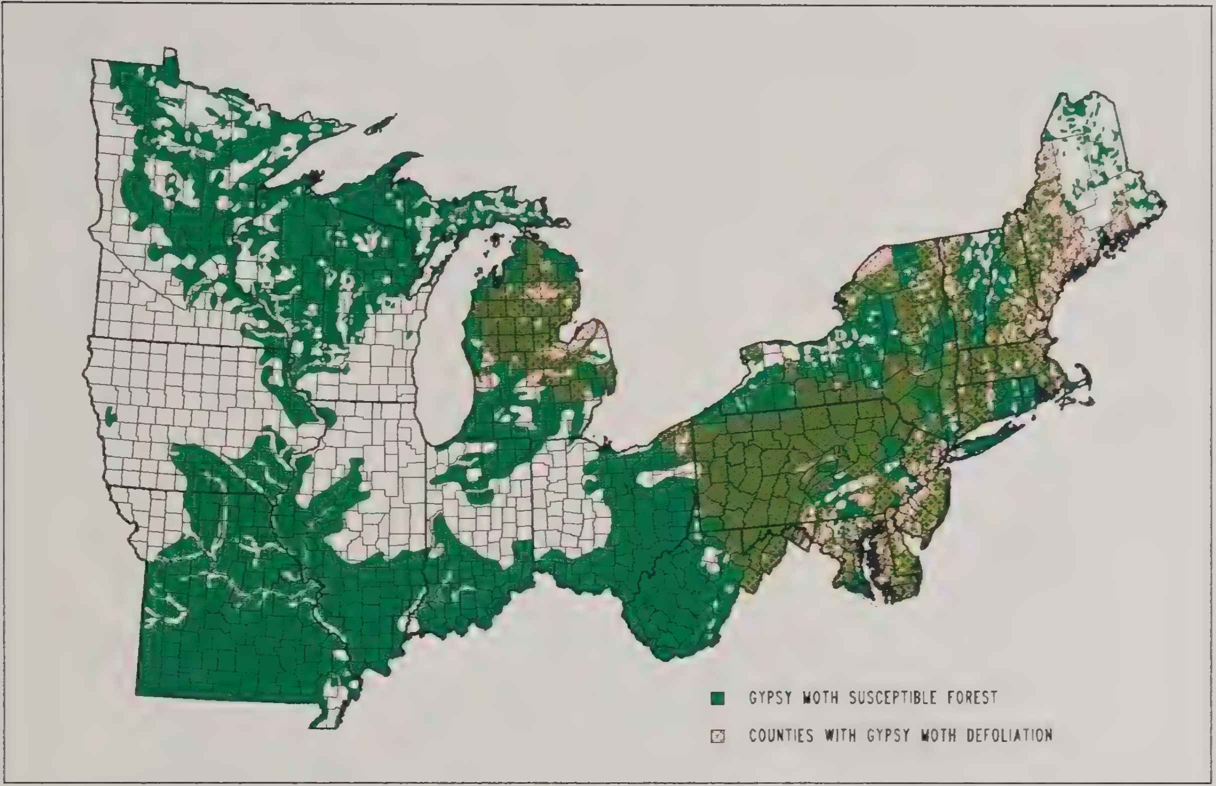


Figure 13*. Counties with Gypsy Moth / Gypsy Moth Susceptible Forest, 1991 (Map Produced by: USDA Forest Service, Northeastern Area - Forest Health Protection GIS Group).*

Table 1. *Gypsy Moth Defoliation, 1989-1991.*

Year	Total Acres Defoliated	Percent Defoliated*
1989	2,995,559	2%
1990	7,304,294	6%
1991	4,152,004	3%

* Acres defoliated as a percent of susceptible forest within the area generally infested with the gypsy moth.

Oak volumes tend to decrease after repeated gypsy moth defoliation. No overall estimates exist as to how much oak has been killed. In some places, oak volume decreases and species composition changes. This can have severe local impacts. For example, in the Tuscarora State Forest in south central Pennsylvania, oak-hickory forests sustained heavy oak mortality during the 1980's. A recent study in West Virginia indicated that an average of 25 percent of a forest stand was dead or dying after two consecutive years of heavy defoliation by the gypsy moth followed by attack from other organisms.

The third major factor to affect oak-hickory forests has been oak wilt, a vascular disease which is transmitted by sap-feeding beetles and through root grafts (Figure 14). Oak wilt affects predominately northern red, pin, and black oaks. It was first recognized as an important disease of oaks in Wisconsin and is now found in 21 states. The disease has killed thousands of trees in localized areas but has been particularly severe in the Midwest. In 1991, the incidence of this disease was most prevalent in the oak-hickory forests of Indiana, Iowa, Michigan, and Minnesota. A survey conducted in 1991 estimated 3,000 oak wilt infection centers in the five-county Minneapolis-St.Paul area. This disease is expected to continue to have serious impact on the oak species within the oak-hickory forests.

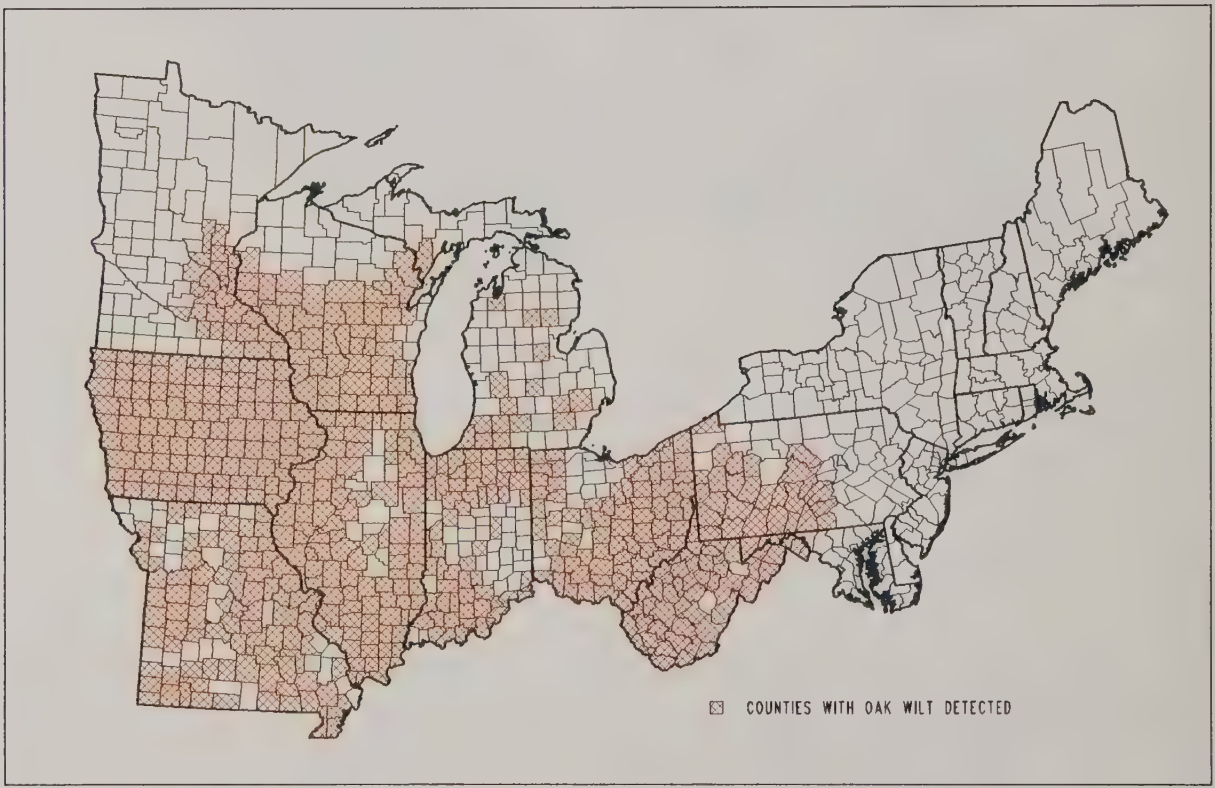


Figure 14. *Oak Wilt Distribution, 1991 (Map produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

Oak decline and mortality was reported in 1991 in Iowa, Michigan, Minnesota, Missouri, and Wisconsin. In general, oak decline is thought to be initiated by a variety of stressors, such as site conditions, foliage diseases, insect defoliation, and especially drought. The 1987-1989 drought in the Midwest made the forest more susceptible to attacks by the two-lined chestnut borer, and in 1991 resulted in extensive oak mortality, scattered over 750,000 acres.

Dogwood, a principal understory tree in the oak-hickory forest, is also an extremely valuable ornamental species. Dogwood anthracnose has recently become an increasing concern. The disease has caused considerable mortality in the southeastern states. It is now reported in Connecticut, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, and West Virginia (Figure 15). It is causing mortality on dogwood in both forest stands and ornamental plantings.

Several other insects and diseases were reported recently affecting oak-hickory forests at noticeable levels, but not to an extent that they would be considered major stress factors. Examples include the fall webworm, oak skeletonizer, orange striped oakworm, eastern tent caterpillar, and oak leaf scorch.

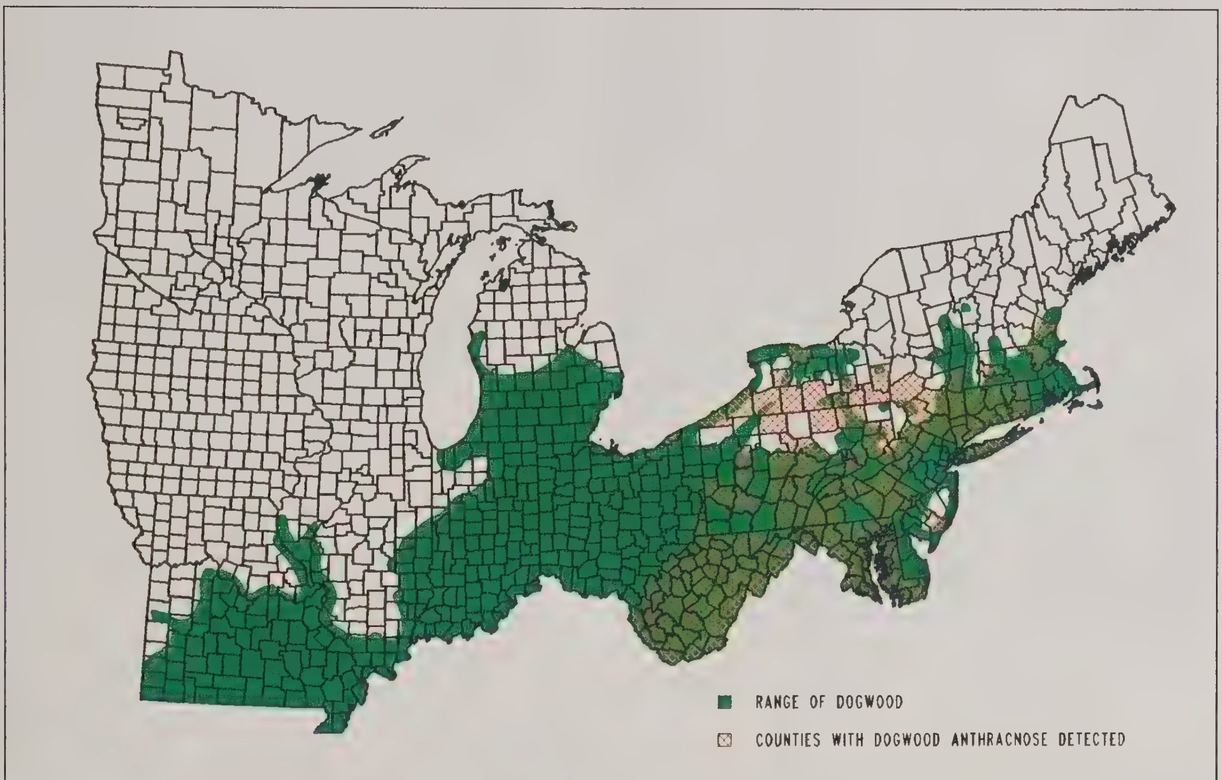


Figure 15. *Counties with Dogwood Anthracnose/Natural Range of Dogwood, 1991 (Map produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

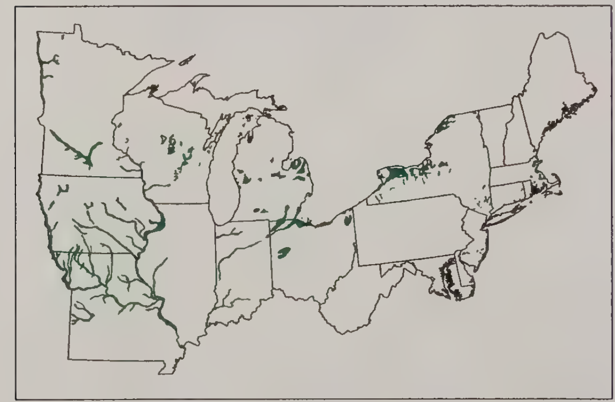
Oak-Gum-Cypress Forest

The oak-gum-cypress forest accounts for only 0.4 percent of the forested area in the Northeastern Area. It is predominant in southeast Missouri, the southern edge of Illinois, Indiana, and Ohio, and small pockets of eastern Maryland, Delaware, southern New Jersey, southern New England, and southern New Hampshire. The major species of the oak-gum-cypress forest include various oaks, which are generally found on moist soils, including pin, swamp chestnut, cherrybark, willow, and overcup. Other hardwood tree species are included, such as sycamore, river birch, sweetgum, and blackgum (tupelo). The major coniferous tree species are Atlantic white-cedar and baldcypress (Figure 16).

Figure 16. Cypress-Tupelo Swamp
(Photo: Manfred Mielke, USDA Forest Service)

Except for foliage diseases, very few major stressors have been reported within the oak-gum-cypress forest in the Northeastern Area. Sycamore anthracnose is well established in the eastern United States throughout the range of sycamore but was not reported in 1991 as causing major damage to sycamore. An anthracnose has been reported on blackgum in the southeastern United States. It has not yet been reported in the Northeastern Area; however, it may become a factor in the near future. The blackgum trees affected in the south are located in the same general areas as dogwoods infected with dogwood anthracnose, and the damage is similar.

Elm-Ash-Cottonwood Forest



The elm-ash-cottonwood (elm-ash-red maple) forest is found throughout the Northeastern Area, and is commonly referred to as lowland or bottomland hardwoods. It is comprised mainly of eastern cottonwood, American elm, green ash, white ash, black ash, and red maple. This forest occupies moist to wet soils and is found in swamps or in lowland areas along streams. Eastern cottonwood and willow will commonly invade bare riverbanks and sandbars.

There are many pests that affect the elm-ash-cottonwood forest, the most serious of which is Dutch elm disease. This vascular wilt, which is spread by a bark beetle, attacks the American elm most often but can attack other members of the elm family. Dutch elm disease has eliminated American elm as an important timber species and is continually a threat to shade trees as a new strain of the fungus spreads. It has drastically altered the composition of the elm-ash-cottonwood forest.

From 1963 to 1990, the city of Minneapolis lost approximately 90,000 out of an estimated 200,000 American elms to Dutch elm disease. In 1963, only 4 American elms died; then the level of mortality gradually increased and, in 1977-1978, over 51,000 were killed.

Region-wide, green ash and white ash are affected by dieback associated with drought. Some of the ash dieback and mortality can be attributed to ash yellows, caused by a mycoplasma-like organism (MLO). Ash yellows has been reported from New York and Pennsylvania west to the central states. In 1991, this disease was reported to be epidemic in northeastern Indiana, and annual mortality was estimated at three percent of the ash population in the state. Several states were surveyed for the disease in the Midwest in 1991 (Figure 17).

The elm-ash-cottonwood forest is somewhat susceptible to the gypsy moth and may experience defoliation when it is adjacent to more susceptible hardwoods. This forest is also susceptible to many abiotic hazards. Changes in the water table can cause stress and mortality in the shallow-rooted elm-ash-cottonwood forest. This was the cause of recent mortality of black ash which occurred in Maine.

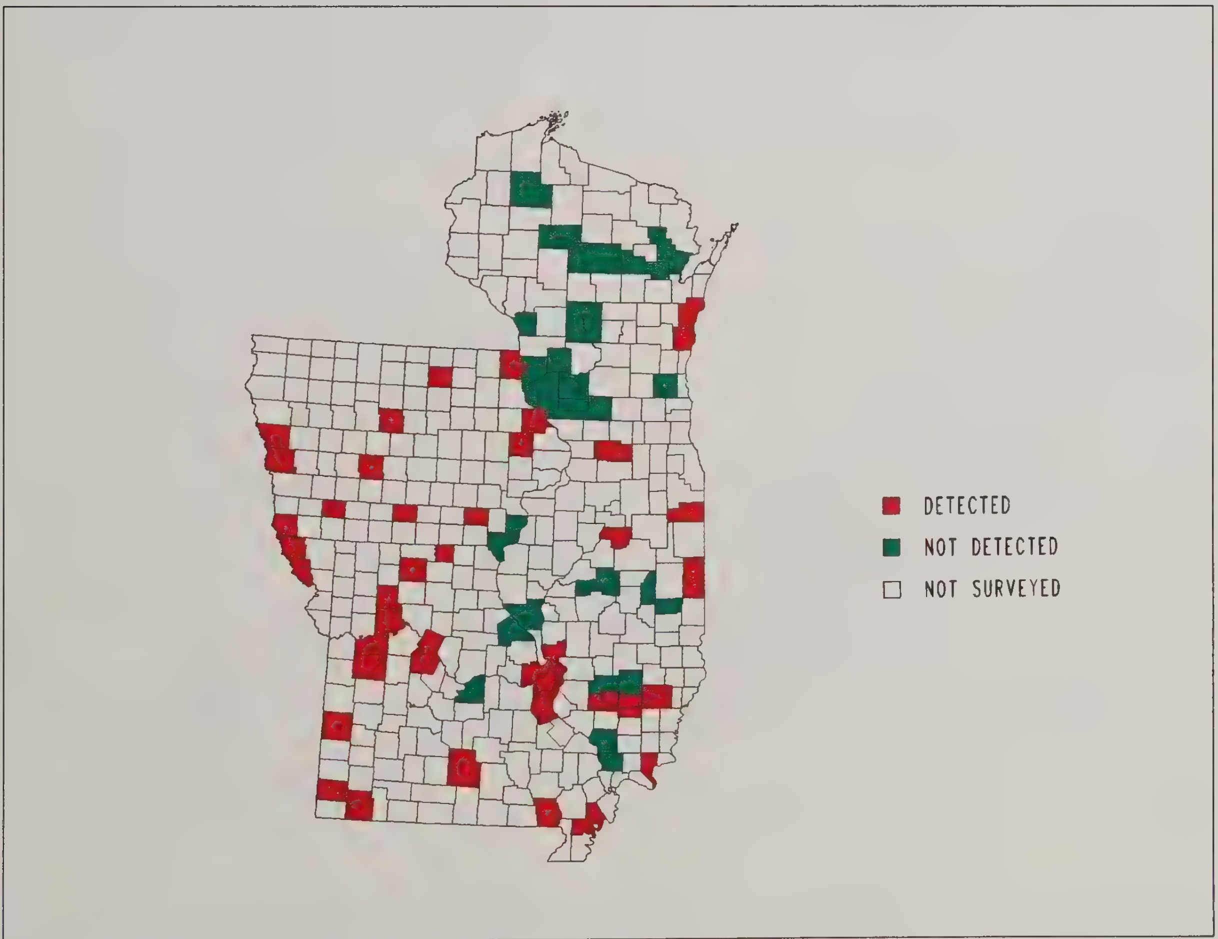
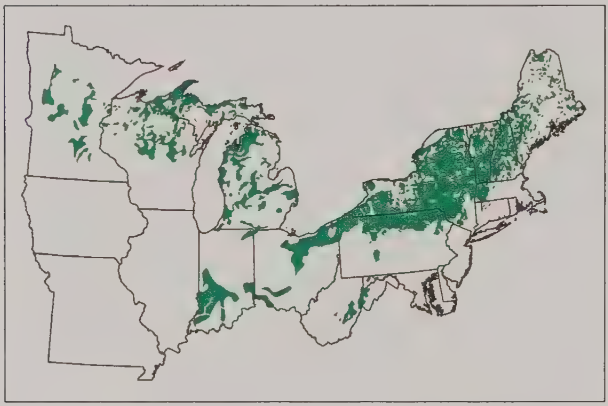


Figure 17. *Ash Yellows in Iowa, Missouri, Illinois, and Wisconsin, 1991 (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

Maple-Beech-Birch Forest



There are approximately 45.1 million acres of maple-beech-birch forest (also known as, Northern Hardwood) in the Northeastern Area, which occurs predominately from central Maine to northern Pennsylvania, at elevations up to 2,500 feet, and in the north central states from Ohio to Minnesota. The largest area is in New York, with 20 percent of the area, followed by Pennsylvania, Michigan, and Maine. The maple-beech-birch forest is comprised mainly of sugar maple, American beech, yellow birch, red maple, and black cherry and occurs on a wide range of soil and site conditions, ranging from shallow bedrock to poorly-drained soils.

The species composition from stand to stand can be quite variable. Older stands are dominated by sugar maple, American beech, and yellow birch, while younger even-aged stands contain paper birch, white ash, and red maple, along with other hardwoods. Conifers grow in with the hardwoods, especially in shallow soils on steep slopes or poorly drained soils at lower elevations. Repeated cutting, fire, and past land use have created numerous combinations of stand conditions, age classes, and species. In the southern extent of the range, the maple-beech-birch species blend with the oak-hickory forest.

Maple-beech-birch forests are affected by numerous insect and diseases. The most visible damage is caused by various defoliators, such as the forest tent caterpillar, pear thrips, Bruce spanworm, fall cankerworm, and the saddled prominent. In 1991, populations of most of these were low, except for the forest tent caterpillar in northern New York, which has affected a large area of sugar maple for several years. Pear thrips became a significant forest pest in the mid-1980's, when several million acres of American beech and sugar maple were damaged in New England, New York, and Pennsylvania. This pest had not been reported previously in forested areas and caused concern over the potential impact to sugarbushes and maple syrup production. Currently, population levels are low, with little damage is reported. A similar problem is occurring on American basswood, caused by basswood thrips, in the Lake States.

The sugar maple borer, an important pest that causes reduction in wood quality, can be found in stands throughout the range of sugar maple. Diseases, such as stem cankers, vascular wilts (sapstreak and verticillium wilt), anthracnose, and stem rots, associated with wounds from logging and tapping, have also caused damage to sugar maple. Sapstreak continues to impact some infected sugar bushes in New York and New England.

Sugar maple "decline" (dieback and mortality) has been reported at various times throughout this century, but surveys suggest that damage was mostly related to pests, drought, and/or management practices. Sugar maple stands have been monitored in the Northeastern Area; most recently, beginning in 1988, through the international North

American Sugar Maple Decline Project. Results indicate that overall sugar maple conditions have improved, and any crown damage that was observed was attributed to defoliation and drought. Forest survey inventories in New England have shown that within the last 10 years there are more numbers of sugar maples with a higher quality than in previous surveys.

Red maple is affected by insects and pathogens similar to those affecting sugar maple. However, the maple "decline" reports are largely confined to sugar maple, with red maple affected to a lesser degree. The species is highly susceptible to damaging canker diseases and decay that cause reduction in wood quality.

The major factor affecting American beech is beech bark disease, which enters the tree through a feeding wound made by a Cryptococcus scale insect. The scale was first introduced into the United States in the early 1930's. The disease now occurs from Maine down to Pennsylvania, Ohio, and West Virginia (Figure 18). Losses due to the disease are significant. By the late 1970's, mortality of sawtimber trees ranged from 50 percent in eastern Maine to about one-third in New Hampshire and Vermont. This disease also affects regeneration, especially sprouts from disease-killed trees. As a result, a higher percentage of smaller trees are now being killed in the areas where the disease has been present the longest. Currently, scale populations are down in New England and New York; however, the disease continues to cause mortality throughout the infected area. There are some trees which appear to be resistant to the scale infestation.

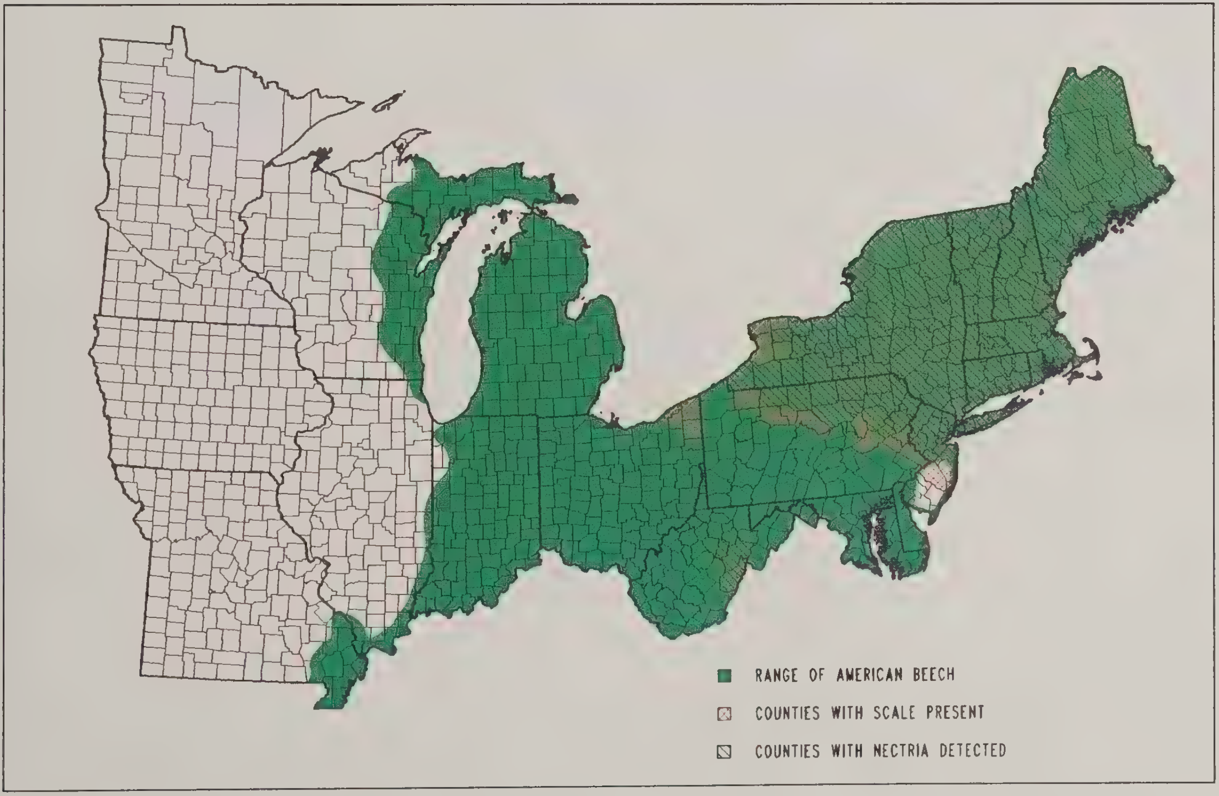


Figure 18. *Counties with Beech Bark / Natural Range of Beech, 1991 (Map produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring- GIS Group).*

Like sugar maple, American beech is also affected by many defoliators. In 1991, trees in northern New York and Vermont were affected by the oystershell scale. American beech is also very susceptible to sudden changes in the environment, such as drought, heat, winter injury, and disturbance from partial cutting and logging wounds because of its thin bark.

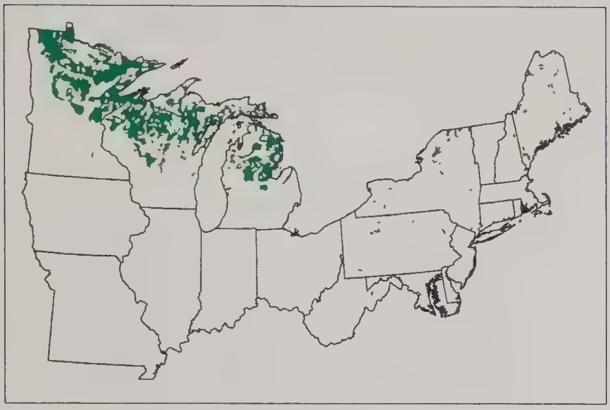
Yellow birch is susceptible to various factors, which in combination cause episodes of "decline". The most significant episode occurred in the 1930's. Areas of northern New England and New York were affected as thousands of square miles of dead yellow birch, along with paper birch, were evident. Although a cause has never been positively identified, it is suspected that lack of snow cover and low winter temperatures lead to death of the roots. Sporadic episodes have also occurred in the 1960's and 1980's. Yellow birch is affected most noticeably by cankers which cause decay and discoloration. Like beech, yellow birch is very susceptible to decay following partial cutting of a stand. In 1991, birch leafminers and skeletonizers defoliated yellow birch in northern New England and New York. Dieback of white birch is occurring in central and eastern Maine, and there is scattered mortality in Vermont. Defoliation and dry weather are contributing factors.

Butternut is a decreasing component of the maple-beech-birch and oak-hickory forests due to continuing tree mortality caused by butternut canker. Tree dieback and decline due to this disease has been reported since the 1960's. Mortality was widespread in southwestern Wisconsin in 1967, and the disease became established in southeastern Minnesota by the early 1970's. Severe losses throughout the range of butternut is threatening the survival of the species, as the disease contiues to spread.

Most of the remaining butternut is in Wisconsin. About 58 percent (38,952 M cu ft) of the total growing stock volume and 68 percent (123,867 M bd ft) of the sawtimber is located there.

The impact from insects and pathogens on the maple-beech-birch forests has been varied, from butternut canker to cyclic episodes of insect defoliation and drought. Overall, most maple-beech-birch tree species are growing well. Tree-ring studies have concluded that hardwood species in the Northeastern Area have not shown a steady decline in the last few decades. They do show short periods of poor growth in response to below normal precipitation and insect defoliation.

Aspen-Birch Forest



The aspen-birch forest occurs throughout New England, New York, northern Pennsylvania, and the Lake States. It is comprised mainly of quaking aspen, bigtooth aspen, paper birch, balsam poplar, and pin cherry. These forests chiefly occur in areas of old burns, clearcuts, or abandoned fields and pastures. Without repeated disturbance, the aspen-birch forest is succeeded by spruce-fir and pine in the northern region or maple-beech-birch and eastern hemlock to the south.

The aspen-birch forest is favored by the forest tent caterpillar, which can defoliate large areas, such as occurred in the Lake States in 1991 (Figure 19). Outbreaks usually last only a few years. Approximately two million acres were defoliated by the forest tent caterpillar from Maine to Minnesota since 1987. The gypsy moth readily defoliates aspen-birch forests throughout the generally infested area. Repeated defoliation by these insects, in association with other organisms, will cause reduction in volume, mortality, and a reduction in the number and quality of root and stump sprouts for regeneration.

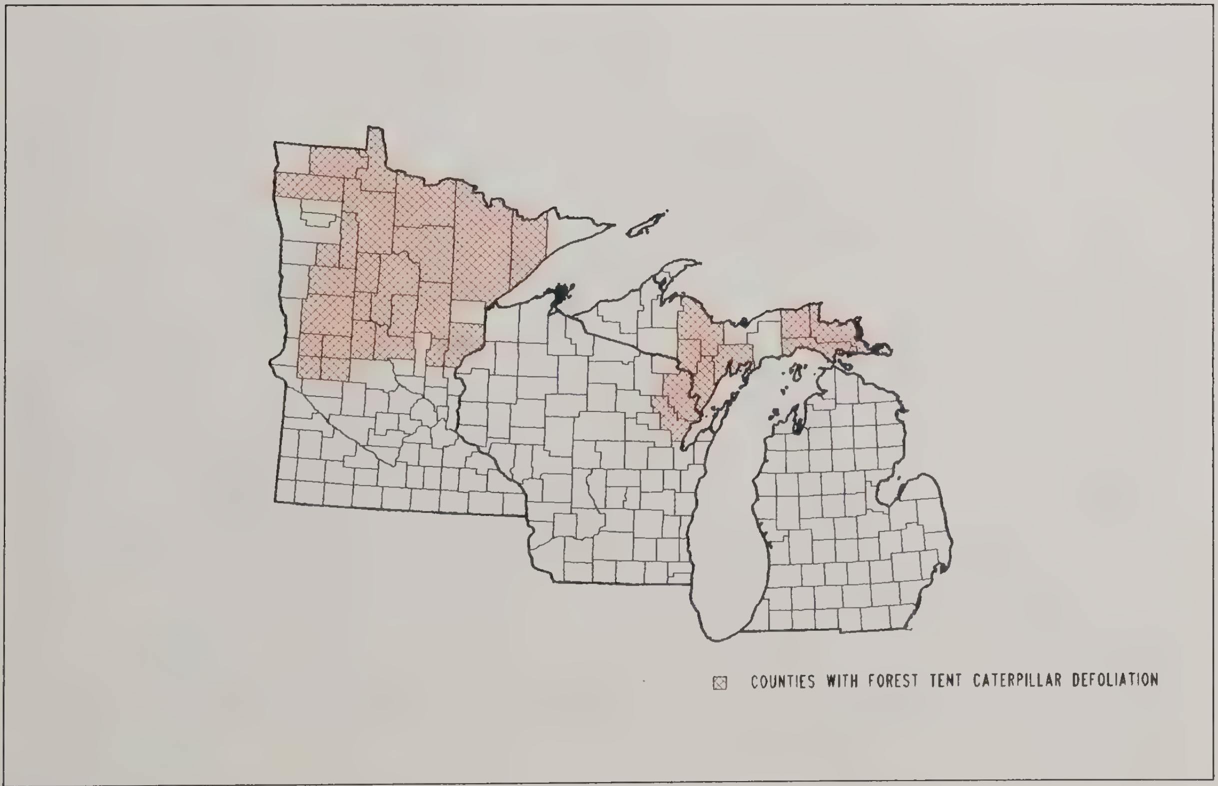


Figure 19. *Forest Tent Caterpillar Distribution in the Lake States, 1991 (Map Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

In 1991, several other insects caused damage in the aspen-birch forest. Birch leafminers defoliated over 100,000 acres in central and coastal Maine and, to a lesser extent, areas in Vermont. The birch skeletonizer defoliated areas in Maine and New York and caused scattered defoliation in Vermont. The bronze birch borer and bronze poplar borer caused light mortality on poorly-drained lowlands in the Upper Peninsula of Michigan and a small area in Minnesota.

Urban Forests

Forest type descriptions are useful in areas that are predominantly forested, but human habitation in some places has become so dense that only remnants of natural species remain. Many non-native species, introduced for a variety of aesthetic, productive, social, and nostalgic reasons, further alter the indigenous woodland. These areas of woody vegetation within cities and their surrounding communities have become known as the urban forest (Figure 20).

The Northeastern Area states contain nearly half the nation's population and a large portion of its cities. Urban areas are comprised of many land uses: residential, transportation, industrial, institutional, commercial, parks, agricultural, undeveloped, and other. About 30 percent of this area is presently forested, with even more land available as growing space. Urban forest lands are small in proportion to other forested land but are an important entity of their own. They are managed more intensively, have higher recreational use, and have more dollars invested in them than other timberlands.

Figure 20. *Boston,MA, Commonwealth Avenue Mall Looking Toward Public Garden (Photo: Phyllis Anderson).*

Urban forests have environmental, economic, and aesthetic value. Trees moderate temperature in a city by providing shade and cutting down solar radiation. Trees reduce air pollution by absorbing gas pollutants and filtering particulate matter such as dust, ash, and smoke. Trees and shrubs reduce noise pollution, light glare, soil erosion, and provide wind protection. Urban forests are important for recreational and aesthetic reasons and provide wildlife habitat and natural areas which contribute to the well-being of city residents.

The urban forest has many unique health problems, as well as the usual array of insect and disease epidemics occurring in the region. Trees may be stressed due to excess heat, water problems, compacted and poor soil, pollution, road salt, lack of growing space, and physical injury from human activities. In a 1986 survey, the most common insect problems reported by city managers in the Northeast were gypsy moth, ants, Japanese beetle, aphids, tent caterpillar, scale, webworm, elm bark beetle, and bagworm. The most significant disease problems reported were Dutch elm disease, maple decline, anthracnose, ash dieback, and oak wilt. Most of these insects and diseases continued to be a problem in urban forests of the Northeastern Area in 1991. A variety of ornamentals and shade trees such as oak, dogwood, hemlock, maple, and elm are species affected. Oak wilt is an important disease in urban areas in the Midwest. Hemlock woolly adelgid was reported to be increasing on hemlock in southern New England, New York, New Jersey, Maryland, Pennsylvania, and West Virginia. Dogwood anthracnose has also become a major concern in these states. Armillaria root disease is commonly reported on trees such as roadside maples, and trees stressed by other factors like insect defoliation. Dutch elm disease continues to cause mortality of shade trees as a new strain of the fungus spreads throughout the area. The gypsy moth caused severe defoliation of many oaks, birches, and ornamentals in the region's urban areas. The extent and impact of these pests are further discussed within the various forest sections of this report.

Urban forest management is being promoted throughout the cities and towns of the Northeastern Area. A five-year plan has been developed that provides a strategy for creating and maintaining healthy and productive urban forests. Each state has identified an urban forestry coordinator and an urban forestry council to promote and oversee their individual programs. Landscape programs across the country encourage planting and care of urban vegetation. Trees and other plants contribute much to the urban environment, and the health of the urban forest is an important component in forest management.

General Stressors

Fire

Just as the different forests are affected by insects and pathogens to varying degrees, fire's role within each forest also varies. For example, pitch pine forests are more fire susceptible than maple-beech-birch forests. The type and amount of fuels in a forest is directly influenced by the dominant species. Forest condition affects, and contributes to, the susceptibility and vulnerability of a stand to fire. The health of the forest affects the probability that a fire will start at all, and the intensity of the fire once it has begun burning.

New Jersey's Pine Barren forest is an example of an ecosystem where fire plays a major role. The Pine Barrens are classified as an extremely hazardous wildfire fuel type, similar to chaparral in California. Fires in the Pine Barrens burn extremely hot and spread rapidly. In 1991, rainfall was well below normal in the this area. In addition, pine looper defoliation may have increased the already high fire danger.

Drought is the primary stress agent which controls the impact from forest fires. Long-term moisture deficiencies can translate into low live fuel moisture which in turn affect fire intensity once a fire has started. The lack of precipitation during critical periods of the year contributes to an increased chance of ignition.

Stands affected by insects or pathogens will also exhibit altered fire behavior. As with drought, the type and timing of the stress will change a fire's effects. Stands with large foliage loss during, or followed by, a dry spell can increase the amount of fine fuels available. The fuels will likely cause the fire to burn more rapidly and increase the rate of spread and the intensity of the burn. Large numbers of dead trees within a stand can increase the intensity of the fire enough to cause fire-induced mortality on individual trees or species not affected by the initial stress, nor normally affected by fire.

Fires can also have a beneficial effect upon the forest. Smaller periodic fires have the effect of reducing the fuel buildup, thus preventing an accumulation of fuels which could cause an intense fire resulting in high mortality. The amount of downed fuel should be considered in assessing the health of the forest.

The forests also benefit from the "antiseptic" effect of fire. In an area with large populations of insects or pathogens, fire can reduce the presence of these pathogens and increase the overall condition of the forest. Fires also improve the overall health of the forest by creating a diverse habitat and inserting stands of pioneer species into large expanses of even age stands with a small number of species present. Some species even require fire for regeneration. For example, jack pine cones require the intense heat of a fire to release their seeds and prepare the seedbed for germination.

State	Acres	
	1991	Five-year Average
Connecticut	1,679	2,585
Delaware	538	1,037
Illinois	7,491	4,544
Indiana	604	2,393
Iowa	5,700	6,828
Maine	3,098	2,462
Maryland	8,249	5,545
Massachusetts	4,253	6,052
Michigan	1,473	8,201
Minnesota	51,909	80,469
Missouri	75,991	45,539
New Hampshire	296	492
New Jersey	4,256	5,191
New York	3,394	4,643
Ohio	2,679	6,270
Pennsylvania	3,905	10,648
Rhode Island	269	303
Vermont	747	437
West Virginia	346,197	127,051
Wisconsin	1,765	5,555

Figure 21. *Acres of Forest Burned in the Northeastern Area, 1991 versus 5-year Average.*

With a few notable exceptions, 1991 was a fairly typical fire year in the Northeastern Area (Figure 21). Seven states reported fire occurrence above their five-year averages - Illinois, Maine, Missouri, New Jersey, New York, Rhode Island, and Vermont. The overall number of fires reported were 84 percent of the five-year average, while the acres burned exceeded the five-year average by 61 percent.

Missouri's increase was attributed to a better reporting system, which accounted for a more accurate total than in the past. West Virginia reported a fewer number of fires compared to their average, but acres burned were almost triple their five-year average. The increase in acres burned in six states contributed to a 60 percent increase in average fire size in the Northeastern Area. It is conservatively estimated that only 25 percent of the total wildland fires occurring in the Northeastern Area are reported to the State Forestry Agencies.

Weather

The primary concern about weather has been drought. Defining what constitutes a drought historically has been based on crop successes or failures. No single measure of drought perfectly represents moisture conditions in all areas. However, the United States Department of Commerce, National Oceanic and Atmospheric Administration, attempts to represent meteorological drought (or moisture excess) conditions by area units referred to as climate divisions. There are 344 climate divisions nationally, and they were created in 1949 based on several factors, including crop types, old crop

reporting districts, and political boundaries. Thousands of individual daily weather station reports are summarized, and these data are entered into mathematical models; then different indexes are calculated that represent meteorological moisture conditions in various ways.

The Palmer Index is one of several measures used to describe meteorological moisture anomalies. Within this report, the index is called the Palmer Hydrological Drought Index (PHDI), and ranges from extremely wet (4.0) to extremely dry (-4.0). The Palmer Indexes are computed as the product of a climate weighting factor and moisture departure. The weighting factor standardizes the index to enable reasonable comparison of index values in different locations and different times of the year. Moisture departure is the difference between water supply (precipitation, stored soil moisture) and water demand (potential evapotranspiration, the amount needed to recharge the soil, and runoff needed to keep rivers, lakes, and reservoirs at normal levels).

PHDI is an index that attempts to represent water table and ground water effects of drought and is slow to respond to sudden changes in weather. The PHDI Maps for the Northeastern Area are shown in Figures 22 to 26. According to the annual average, PHDI (based on monthly summaries from October - September), large areas of the northeastern United States began to experience severe to extremely dry conditions starting in 1987 and continuing through 1989. Several climate divisions, mainly in the northern Lake States, had a continuation of drought conditions into 1990 and 1991.

This extended period of drought has had serious consequences for tree health throughout the Northeastern Area. Leaf scorch, chlorosis, leaf curling, dropped leaves, and scattered mortality are some of the symptoms observed. Drought was directly responsible for the death of millions of oak and pine trees in the Lake States in 1989. Much of the mortality that has occurred since then is as a result of the lingering effects of drought, including mortality of green and white ash in the Midwest and birch in Maine. Trees that survived the direct effects of the drought were weakened and made susceptible to other stressors that under normal circumstances would not have been significant, such as oak in the Midwest being killed by the two-lined chestnut borer and deteriorated crown conditions on maple in Wisconsin. Scattered mortality occurred in Minnesota and Iowa from the effects of past years' drought. Indiana reported light mortality on yellow poplars, sugar maples, white pine, and black cherry. Residential and rural oaks have been affected in Delaware, and leaf symptoms occurred on hardwoods in Vermont. Drought conditions existed in northern West Virginia and central and western New York with no symptoms observed.

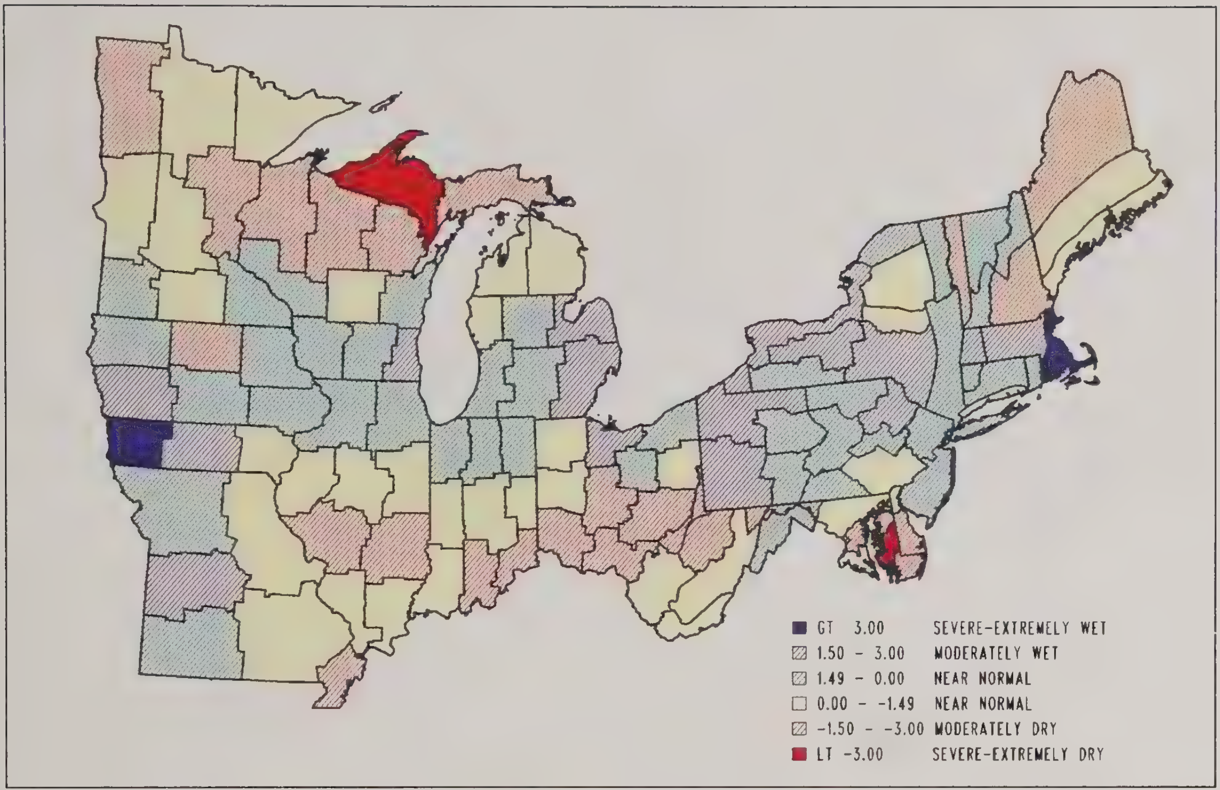


Figure 22. *Palmer Hydrologic Drought Index, 1987 by Climate Division (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

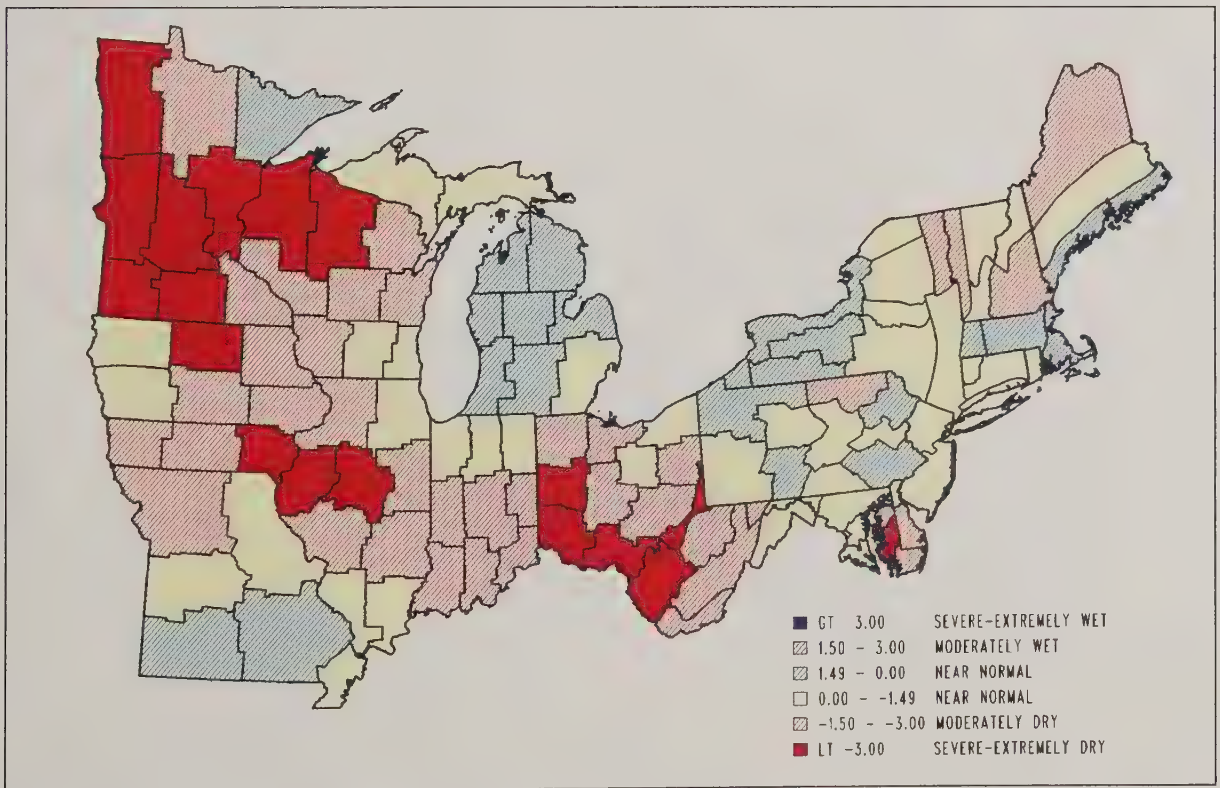


Figure 23. *Palmer Hydrologic Drought Index, 1988 by Climate Division (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

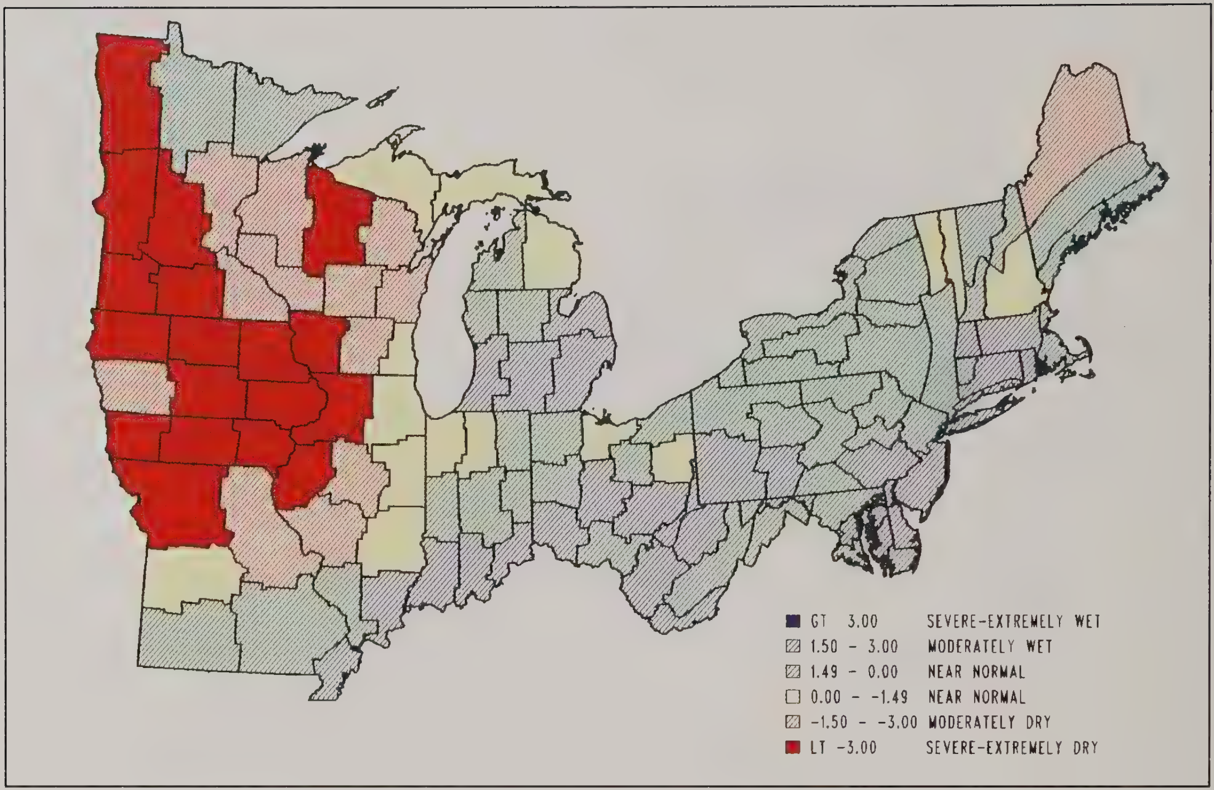


Figure 24. *Palmer Hydrologic Drought Index, 1989 by Climate Division (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

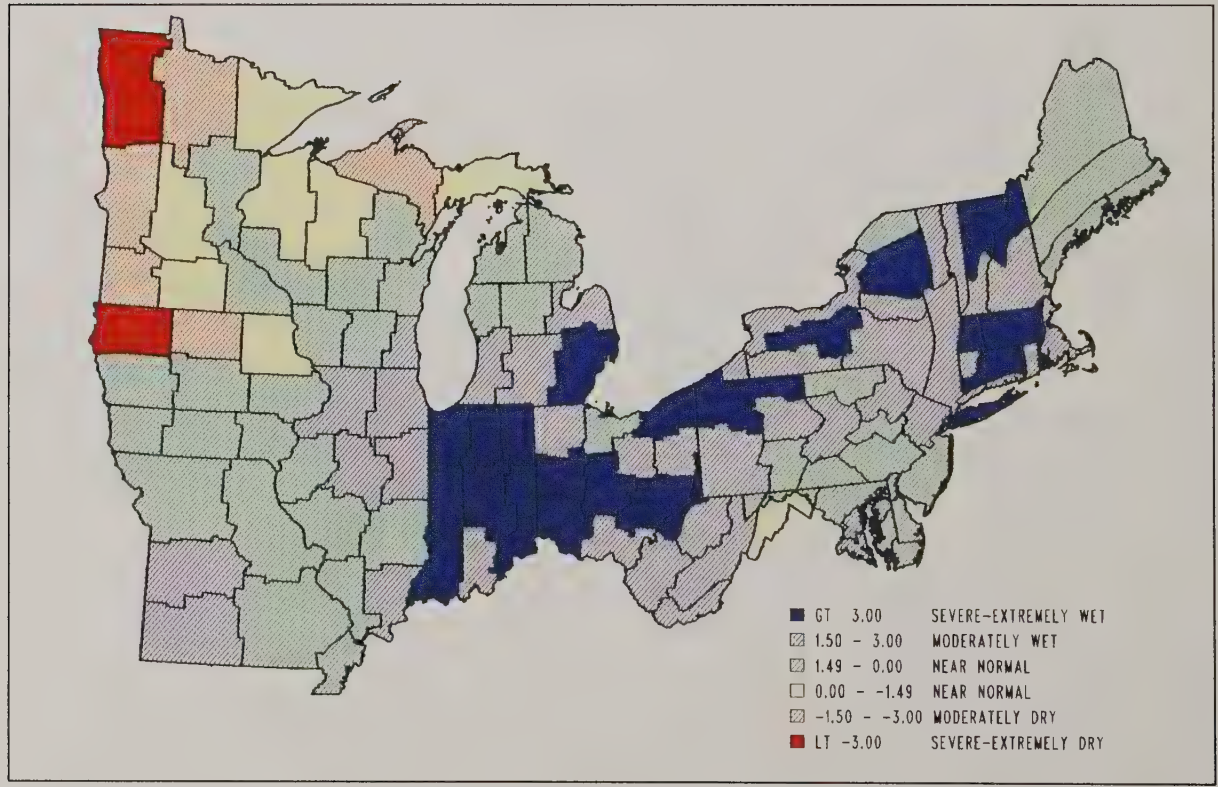


Figure 25. *Palmer Hydrologic Drought Index, 1990 by Climate Division (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

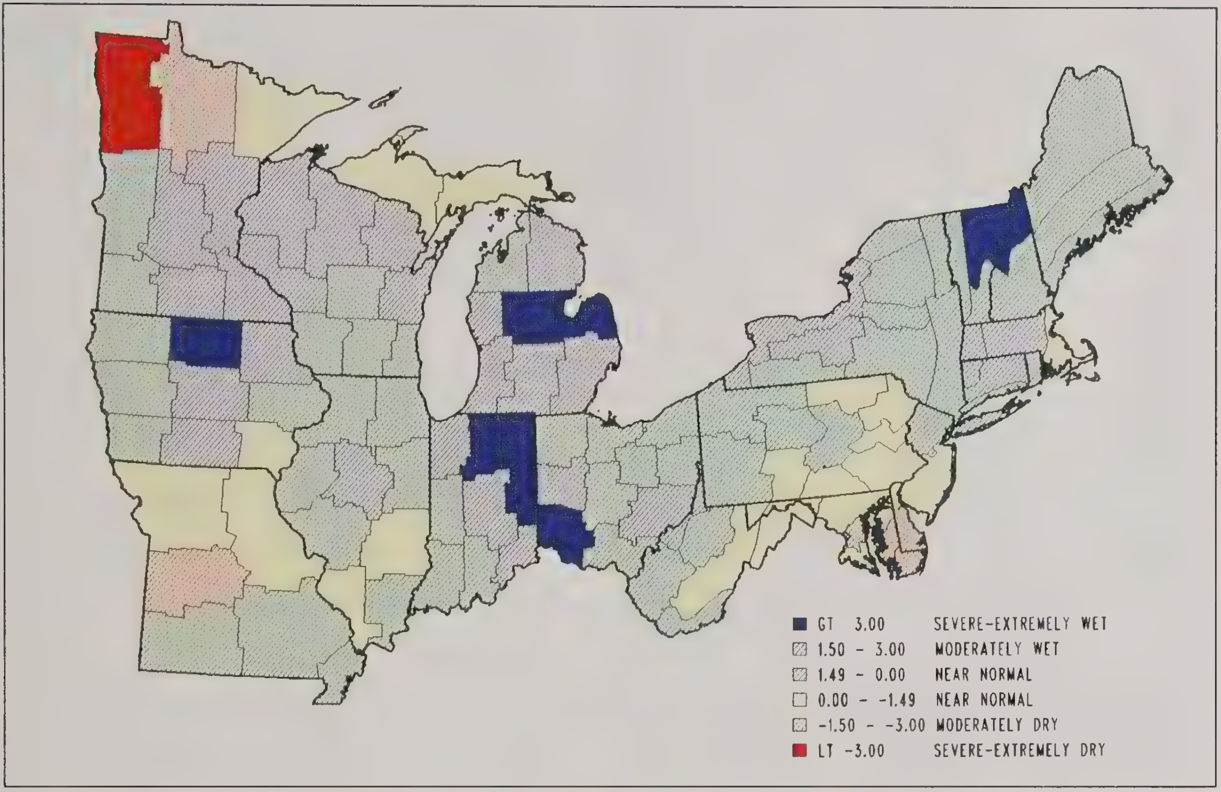


Figure 26. *Palmer Hydrologic Drought Index, 1991 by Climate Division (Produced by: USDA Forest Service, Northeastern Area - Forest Health Monitoring GIS Group).*

Figure 27. Ice Damage (Photo: Susan Cox, USDA Forest Service)

Late spring frosts can kill new growth on sensitive species whenever it occurs after trees begin their growing season. In 1991, northern Vermont reported balsam fir, other Christmas trees, and sensitive hardwoods affected by a late frost. Balsam fir shoots in low lying areas of Maine were affected by frost, causing shoot mortality.

Ice storms cause damage by breaking tops and branches, snapping trunks, and uprooting trees (Figure 27). Heavy ice can cause limbs to droop, which results in internal injuries that are harder to detect. In 1991, up to an inch of ice damaged trees in central and western New York. The Rochester and Monroe County area reported the most damage with 30 percent of the trees killed and another 30 to 50 percent with significant crown damage. The most affected species were ash, soft maples, pine, larch, willow, and other stressed or weakened trees. Severe spring storms also damaged trees in fence rows, forests, and yards in Wisconsin and Indiana.

Hurricane Bob hit the New England coast damaging forest and ornamental trees with high winds and salt spray. Cape Cod, Massachusetts was the hardest hit with pockets of severe damage occurring throughout the area. Most susceptible were black locust, pines, older oaks, street trees, and other stressed trees. Trees were uprooted, twisted, and broken and many were left leaning. Remnants of the damage is expected to be evident for years.

Air Pollution

There are three major aspects of air pollution that can cause a response in forests; gases (specifically ozone), wet deposition, and dry deposition (the latter two aspects are grouped as acidic deposition). Ozone is a gas that may cause injury to sensitive tree species. Symptoms such as purple speckling may appear on the upper surface of the leaf on hardwoods or yellow mottling on white pine. Acidic deposition is a direct result of sulfur and nitrogen compounds in the atmosphere and, in the case of wet deposition, involves a reaction with precipitation. Acidic deposition is measured in amounts of hydrogen (or pH, a measure of acidity), sulfate, nitrate, nitrite, and ammonium ions. This deposition can influence nutrient cycling in the forest. Monitoring information for ozone and wet and dry deposition comes from a series of networks distributed throughout the United States, and the number of individual monitoring sites varies from state to state.

Ozone has only been monitored since the early ‘60’s, so long-term information is limited. In addition, the number of sites has been increasing, and many of the sites are in urban locations. Ozone damage within a localized area can be scattered, and it is possible for two neighboring trees of the same species to exhibit different levels of damage. In addition, ozone values can differ significantly within a few miles due to elevation changes and other site factors. The tree species more sensitive to ozone damage are eastern white pine and black cherry. Other species of pine, ash, poplar, maple and oak are also sensitive.

The ozone levels for the Eastern Unites States are shown in Figures 28 to 30 (Due to data handling procedures, 1989 is the latest year with complete information). The W126 index is a biological based index for the growing season of April through October. In 1988, most of the eastern United States reported high ozone levels. Vermont reported the highest levels of symptoms ever observed. In 1991, ozone symptoms were reported on a 25-acre eastern white pine plantation in Montgomery county, Michigan. Light occurrence of symptoms was reported in the Wilderness Areas on the White and Green Mountain National Forests. All of the National Forest Wilderness Areas within the Northeastern Area are monitored for ozone caused symptoms.

In general, acidic deposition has not shown any visible effects on forests in the Northeastern Area. In the summary of the Forest Response Program (which ended in 1990), the conclusions from numerous research studies stated,

> “... that most forests in the United States do not show unusual visible symptoms of stress, marked decreases in the rate of diameter or height growth, or significant increases in mortality due to acidic deposition.”

This statement does not hold true for the high-elevation red spruce forests in New York, Vermont, and New Hampshire where acid cloud deposition has been found to predispose trees to winter injury. Acid deposition is affecting the nutrient cycling in some forests and, as a result, impacts on trees could be expected if acid deposition were not reduced. Guidelines in the new Clean Air Act should help reduce deposition.

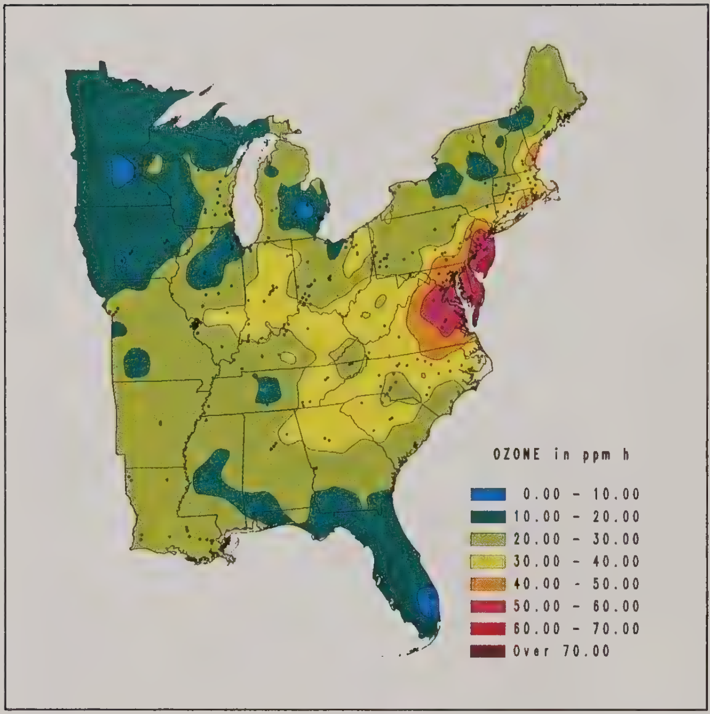


Figure 28. *Ozone Levels - 1985 (Produced by: Environmental Monitoring and Assessment Program - Forests, US-EPA, Research Triangle Park, NC).*
• - Locations used to develop map.

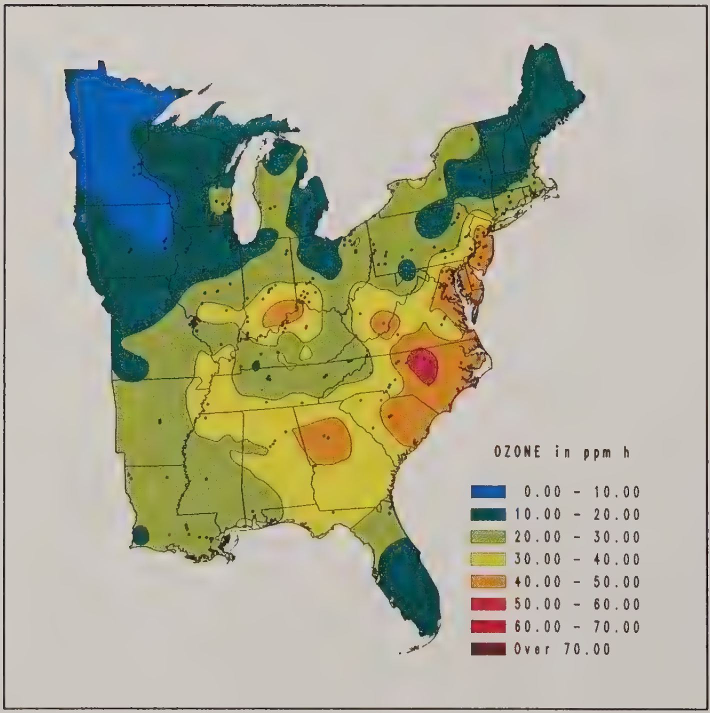


Figure 29. *Ozone Levels - 1986 (Produced by: Environmental Monitoring and Assessment Program - Forests, US-EPA, Research Triangle Park, NC).*
• - Locations used to develop map.

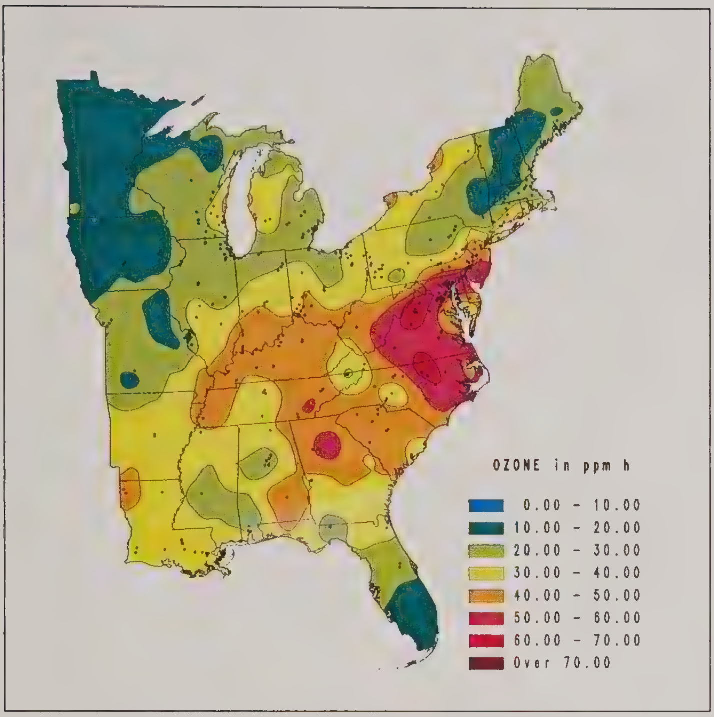


Figure 30. *Ozone Levels - 1987 (Produced by: Environmental Monitoring and Assessment Program - Forests, US-EPA, Research Triangle Park, NC).*
• - Locations used to develop map.

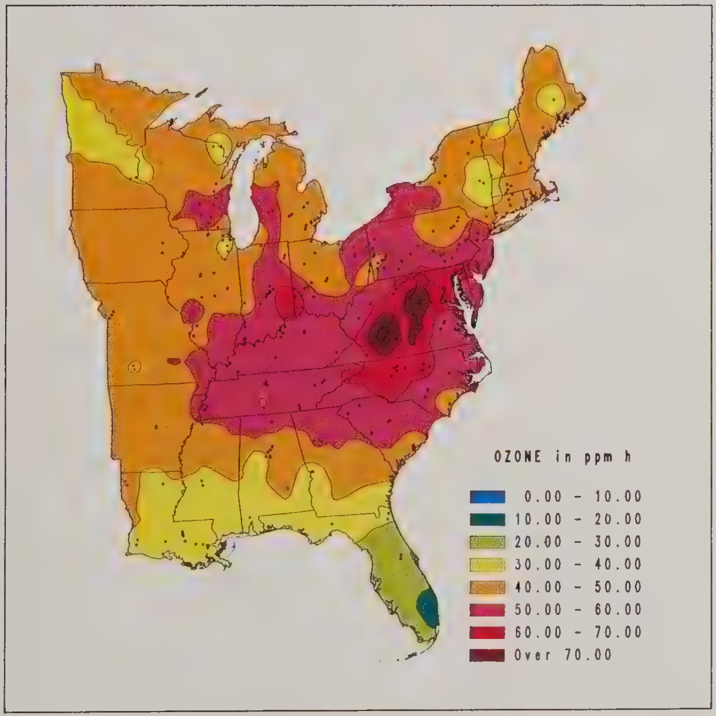


Figure 31. *Ozone Levels - 1988 (Produced by: Environmental Monitoring and Assessment Program - Forests, US-EPA, Research Triangle Park, NC).*
• - Locations used to develop map.

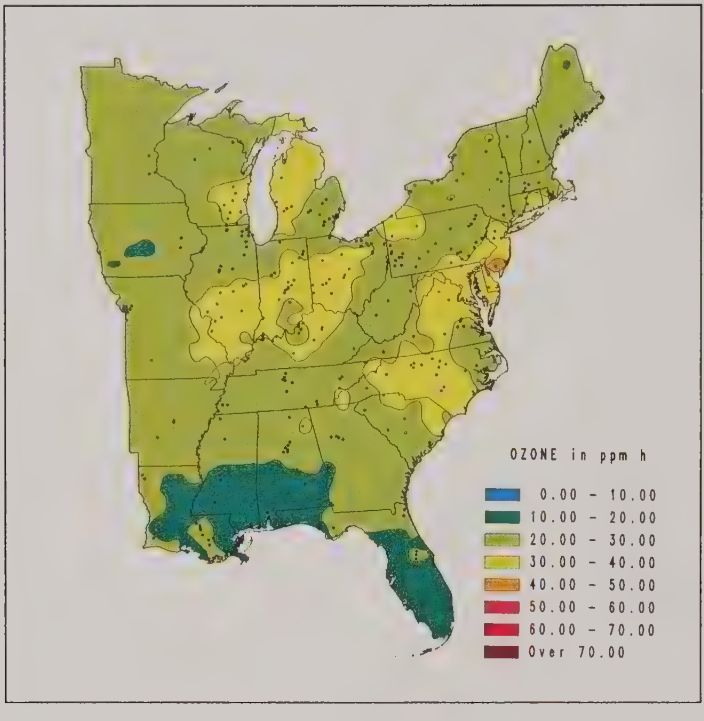


Figure 32. *Ozone Levels - 1989 (Produced by: Environmental Monitoring and Assessment Program - Forests, US-EPA, Research Triangle Park, NC).*
• - Locations used to develop map.

Conclusions

In general, this report finds that pest activity is not uniformly threatening any forest in the Northeastern Area. However, there are concerns over several pest problems occurring in both natural and urban forested areas. These pests mostly affect individual tree species within the forest. Nevertheless, their importance is magnified by their potential impact upon these species. The more notable pest problems include:

- Gypsy moth defoliation, causing oak decline and mortality in the oak-hickory forests and in forested residential communities.

- Beech bark disease, causing extensive mortality to American beech.

- Butternut canker, causing widespread loss of the butternut in oak-hickory and maple-beech-birch forests.

- Dutch elm disease, continuing to cause mortality of American elms.

- Chestnut blight, which practically eliminated and continues to affect the American Chestnut throughout its range.

- Dogwood anthracnose, causing serious losses throughout the range of this important understory and ornamental tree species.

- Eastern hemlock looper and hemlock woolly adelgid, affecting forest and ornamental hemlock.

- White pine blister rust and white pine weevil, limiting eastern white pine planting.

These have been singled out for several reasons: 1) their actual or potential ecological significance to the forest; 2) their economic significance in terms of affecting economically important species or valuable shade or ornamental trees; and 3) their potential for continued impact. It is imperative that the monitoring of each of these pest problems be addressed. Studies should continue to be made to determine the present distribution of the pest, current impacts, and recommendations for both short and long-term actions.

Abiotic factors are also of concern, including ozone damage on sensitive species such as eastern white pine; effects of acidic deposition on the high-elevation red spruce resource; and drought caused tree mortality, particularly in the Lake States. The specific relationship between drought and other tree stressors that result in tree mortality should be assessed. We must understand when trees die because of drought and assess its relationship to other stress factors. The relationship between fire and drought is well-documented and should be emphasized in the New Jersey Pine Barrens pitch pine forests. This area should receive particular attention in terms of wildfire prevention and control.

Although there are localized or regional concerns (e.g. drought effects in the Midwest) and tree species which are being severely impacted (e.g. butternut), the forests within the Northeastern Area are in good health. Continued monitoring of the forests, through various programs, is necessary to identify potential problems, determine the extent of actual concerns, and keep abreast on the condition the forests. The affects of all of these pests and stressors need to be continually monitored to determine the relative health of the forest in the Northeastern Area.

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Appendix I

Common and Scientific Names

Tree Species	Scientific Name
American basswood	*Tilia americana* L.
American beech	*Fagus grandifolia* Ehrh.
American chestnut	*Castanea dentata* (Marsh.) Borkh.
American elm	*Ulmus americana* L.
Aspen	*Populus* spp. L.
Ash	*Fraxinus* spp. L.
Atlantic white-cedar	*Chamaecyparis thyoides* (L.) B.S.P.
Baldcypress	*Taxodium distichum* (L.) Rich.
Balsam fir	*Abies balsamea* (L.) Mill.
Balsam poplar	*Populus balsamifera* L.
Bear oak	*Quercus ilicifolia* Wangenh.
Bigtooth aspen	*Populus grandidentata* Michx.
Birch	*Betula* spp. L.
Bitternut hickory	*Carya cordiformis* (Wangenh.) K.Koch
Black ash	*Fraxinus nigra* Marsh.
Black cherry	*Prunus serotina* Ehrh.
Black oak	*Quercus velutina* Lam.
Black spruce	*Picea mariana* (Mill.) B.S.P.
Black walnut	*Juglans nigra* L.
Black willow	*Salix nigra* Marsh.
Blackgum	*Nyssa sylvatica* Marsh.
Blackjack oak	*Quercus marilandica* Muenchh.
Boxelder	*Acer negundo* L.
Bur oak	*Quercus macrocarpa* Michx.
Butternut	*Juglans cinerea* L.
Carolina hemlock	*Tsuga caroliniana* Englem.
Cherrybark oak	*Quercus falcata* Michx. var. *pagodifolia* Ell.
Chestnut oak	*Quercus prinus* L.
Dogwood	*Cornus florida* L.
Eastern cottonwood	*Populus deltoides* Bartr. ex Marsh.
Eastern hemlock	*Tsuga canadensis* (L.) Carr.
Eastern larch	see Tamarack
Eastern white pine	*Pinus strobus* L.
Elm	*Ulmus* spp. L.
Fraser fir	*Abies fraseri* (Pursh) Poir.
Grape	*Vitis* spp. L.
Gray birch	*Betula populifolia* Marsh.
Green ash	*Fraxinus pennsylvanica* Marsh.
Hackberry	*Celtis occidentalis* L.
Hickory	*Carya* spp. Nutt.

Jack pine	*Pinus banksiana* Lamb.
Loblolly pine	*Pinus taeda* L.
Mockernut hickory	*Carya tomentosa* (Poir.) Nutt.
Mulberry	*Morus* spp.
Northern pin oak	*Quercus ellipsoidalis* E. J. Hill
Northern red oak	*Quercus rubra* L.
Northern white-cedar	*Thuja occidentalis* L.
Overcup oak	*Quercus lyrata* Walt.
Oak	*Quercus* spp. L.
Paper (White)birch	*Betula papyrifera* Marsh.
Persimmon	*Diospyros virginiana* L.
Pignut hickory	*Carya glabra* (Mill.) Sweet
Pin cherry	*Prunus pensylvanica* L. f.
Pin oak	*Quercus palustris* Muenchh.
Pine	*Pinus* spp. L.
Pitch pine	*Pinus rigida* Mill.
Post oak	*Quercus stellata* Wangenh.
Quaking aspen	*Populus tremuloides* Michx.
Red maple	*Acer rubrum* L.
Red pine	*Pinus resinosa* Ait.
Red spruce	*Picea rubens* Sarg.
Redbay	*Persea borbonia* (L.) Spreng.
Redbud	*Cercis canadensis* L.
River birch	*Betula nigra* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees
Scarlet oak	*Quercus coccinea* Muenchh.
Serviceberry	*Amelanchier* spp. Medic.
Shagbark hickory	*Carya ovata* (Mill.) K. Koch.
Shingle oak	*Quercus imbricaria* Michx.
Shortleaf pine	*Pinus echinata* Mill.
Silver maple	*Acer saccharinum* L.
Southern red oak	*Quercus falcata* Michx.
Sugar maple	*Acer saccharum* Marsh.
Sumac	*Rhus* spp. L.
Swamp chestnut oak	*Quercus michauxii* Nutt.
Swamp tupelo	*Nyssa sylvatica* Marsh. var. *biflora* (Walt.) Sarg.
Swamp white oak	*Quercus bicolor* Willd.
Sweet birch	*Betula lenta* L.
Sweetbay	*Magnolia virginiana* L.
Sweetgum	*Liquidambar styraciflua* L.
Sycamore	*Platanus occidentalis* L.
Tamarack	*Larix laricina* (Du Roi) K. Koch
Tupelo	see Blackgum
Virginia pine	*Pinus virginiana* Mill.
Water hickory	*Carya aquatica* (Michx. f.) Nutt.
White ash	*Fraxinus americana* L.
White oak	*Quercus alba* L.
White spruce	*Picea glauca* (Moench) Voss
Willow	*Salix* spp.L.

Witch-hazel	*Hamamelis virginiana* L.
Willow oak	*Quercus phellos* L.
Yellow birch	*Betula alleghaniensis* Britton
Yellow-poplar	*Liriodendron tulipifera* L.

Insect Species	**Scientific Name**
Bagworm	*Thyridopteryx ephemeraeformis* (Haworth)
Basswood thrips	*Thrips calcaratus* Uzel
Beech scale	*Cryptococcus fagisuga* Lindinger
Birch leafminer	*Fenusa pusilla* (Lepeletier)
Birch skeletonizer	*Bucculatrix canadenisiella* Chambers
Bronze birch borer	*Agrilus anxius* Gory
Bronze poplar borer	*Agrilus liragus* Barter and Brown
Bruce spanworm	*Operophtera bruceata* (Hulst)
Conifer swift moth	*Korscheltellus gracilis* (Grote)
Eastern larch beetle	*Dendroctonus simplex* LeConte
Eastern spruce budworm	*Choristoneura fumiferana* (Clemens)
Eastern tent caterpillar	*Malacosoma americanum* (Fabricius)
Elongate hemlock scale	*Fiorinia externa* (Ferris)
European pine sawfly	*Neodiprion sertifer* (Geoffroy)
Fall cankerworm	*Alsophila pometaria* (Harris)
Fall webworm	*Hyphantria cunea* (Drury)
Forest tent caterpillar	*Malacosoma disstria* Hubner
Gypsy moth	*Lymantaria dispar* (L.)
Hemlock looper	*Lambdina fiscellaria* (Guen.)
Hemlock woolly adelgid	*Adelges tsugae* Annand
Jack pine budworm	*Choristoneura pinus pinus* Freeman
Jack pine sawfly	*Neodiprion pratti banksianae* Rohwer
Japanese beetle	*Popillia japonica* Newman
Looper	*Lambdina athasaria* (Walker)
Nantucket pine tip moth	*Rhyacionia frustana* (Comstock)
Native elm bark beetle	*Hylurgo-pinus rufipes* (Eichhoff)
Oak skeletonizer	*Bucculatrix ainsliella* Murtfeldt
Orangestriped oakworm	*Anisota senatoria* (J.E. Smith)
Oystershell scale	*Lepidosaphes ulmi* (L.)
Pear thrips	*Taeniothrips inconsequens* (Uzel)
Pine looper	*Lambdina pellucidaria* (Grote and Robinson)
Pine needleminer	*Exotelia pinifoliella* (Chambers)
Red pine beetle	*Ips pini* (Say)
Red pine scale	*Matsucoccus resinosae* Bean & Godwin
Redheaded jack pine sawfly	Neodiprion *rugifrons* Middleton
Saddled prominent	*Heterocampa guttivitta* (Walker)
Smaller elm bark beetle	*Scolytus multistriatus* (Marsham)
Southern pine beetle	*Dendroctonus frontalis* Zimmermann
Spruce beetle	*Dendroctonus rufipennis* (Kirby)
Sugar maple borer	*Glycobius speciosus* (Say)
Two-lined chestnut borer	*Argilus bilineatus* (Weber)
White pine weevil	*Pissodes strobi* (Peck)

Disease	Causal Organism
Armillaria or shoestring root rot	*Armillaria* spp. (Fr.:Fr.) Staude
Beech bark disease(complex)	*Nectria coccinea* (Pers.:Fr.) Fr. var. *faginata* Loh., Wats., & Ay. and *N. galligena* Bres.
Butternut canker	*Sirococcus clavigignenti-juglandacearum* N.B. Nair, Kostichka & Kuntz
Chestnut blight	*Cryphonectria parasitica* (Murr.) Barr
Comandra rust	*Cronartium comandrae* Pk.
Dogwood anthracnose	*Discula destructiva* sp. nov.
Dutch elm disease	*Ophiostoma ulmi* (Buism.) Nannf.
European larch canker	*Lacnellula willkommii* (R. Hartig) Dennis
Hypoxylon canker	*Hypoxylon mammatum* (Wahl.) Miller
Oak wilt	*Ceratocystis fagacearum* (Bretz.) Hunt
Sapstreak	*Ceratocystis coerulescens* (Munch) Bakshi
Sycamore anthracnose	*Apiognomonia veneta* (Sacc. & Speg.) Hohn.
Verticillium wilt	*Verticillium albo-atrum* Reinke & Berth.
White pine blister rust	*Cronartium ribicola* Fisch.

Addendum

This replaces Table 2 located on page 56. The column headings of the original were incorrect.

Appendix II

Table 2 - Land Area by Class and State *(in thousands of acres - based on current published Forest Inventory Reports).*

State	Forestland	Noncommercial Forestland	Non-Forest	Total
CT	1,777.3	48.4	1,292.2	3,117.8
DE	376.4	13.1	847.2	1,236.7
IA	1,458.7	102.6	34,306.3	35,867.6
IL	4,029.9	235.6	31,364.5	35,630.0
IN	4,295.8	143.6	18,562.9	23,002.3
MA	2,929.4	295.8	1,782.4	5,007.6
MD	2,424.0	279.3	3,592.2	6,295.5
ME	17,060.2	547.2	2,229.4	19,836.8
MI	17,489.5	879.3	17,994.1	36,362.9
MO	13,370.8	627.4	30,126.7	44,124.9
MN	13,695.1	3,014.1	34,035.6	50,744.8
NH	4,812.1	175.1	768.3	5,755.5
NJ	1,864.3	142.4	2,772.8	4,779.5
NY	15,405.8	3,100.4	11,729.6	30,234.8
OH	6,917.1	203.0	19,108.4	26,228.5
PA	15,923.7	902.2	11,952.2	28,778.1
RI	371.7	33.1	270.3	675.1
VT	4,422.1	122.3	1,390.3	5,934.7
WI	14,759.4	591.9	19,481.5	34,832.8
WV	11,917.7	208.8	3,309.5	15,436.0
Total	**155,301.1**	**11,665.6**	**246,915.4**	**413,881.9**

Disease

Armillaria or sho
Beech bark disea

Butternut canker

Chestnut blight
Comandra rust
Dogwood anthrac
Dutch elm diseas
European larch c
Hypoxylon canke
Oak wilt
Sapstreak
Sycamore anthra
Verticillium wilt
White pine bliste

Appendix II

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Total	**155,301.1**	**11,665.6**	**246,915.4**	**413,881.9**

Table 3 - Timberland by State and Forest Type Group *(in thousands of acres - based on current published Forest Inventory Reports).*

State	White/ Red/ Jack PIne	Spruce/ FIr	Hard-Pine	Oak/ Pine	Oak/ Hickory	Oak/ Gum/ Cypress	Elm/ Ash/ Cottonwood	Maple/Beech Birch	Aspen/ Birch	Unstocked	Total
CT	165.6	14.5	19.2	48.1	996.1	0.0	129.9	433.9	0.0	0.0	1,777.3
DE	0.0	0.0	81.0	60.3	157.1	57.9	10.3	9.8	0.0	0.0	376.4
IA	0.0	0.0	0.0	34.9	813.6	0.0	416.4	143.6	7.8	42.4	1,458.7
IL	20.2	0.0	45.5	13.3	2,025.0	137.8	720.6	1,046.4	0.0	21.1	4,029.9
IN	54.7	0.0	94.5	104.2	1,436.7	82.6	848.9	1,633.7	0.0	40.5	4,295.8
MA	775.7	37.0	111.8	257.0	917.5	0.0	124.7	671.3	34.5	0.0	2,929.4
MD	53.1	0.0	296.9	281.9	1,454.4	120.2	83.7	133.8	0.0	0.0	2,424.0
ME	2,194.7	7,770.5	8.3	36.2	306.5	0.0	238.2	5,000.9	1,504.9	0.0	17,060.2
MI	1,706.7	2,544.5	0.0	0.0	1,773.6	0.0	1,326.4	6,098.4	3,781.4	172.2	17,489.5
MO	0.0	0.0	232.8	1,084.7	10,294.8	117.3	627.0	995.7	0.0	18.5	13,370.8
MN	816.0	2,944.1	0.0	0.0	893.9	0.0	738.1	1,283.9	6,848.8	169.4	13,695.1
NH	1,356.0	677.6	41.7	99.9	395.2	0.0	32.3	2,003.6	205.8	0.0	4,812.1
NJ	24.4	0.0	531.0	113.5	882.6	93.5	110.3	108.6	0.0	0.0	1,864.2
NY	1,569.3	754.6	85.9	91.3	1,888.5	0.0	907.0	9,330.9	778.3	0.0	15,405.8
OH	165.9	0.0	139.9	19.5	4,256.3	0.0	751.7	1,506.7	77.1	0.0	6,917.1
PA	586.2	78.7	197.7	133.2	7,510.1	9.9	599.6	6,311.3	497.0	0.0	15,923.7
RI	17.0	0.0	12.5	29.5	256.1	0.0	23.0	27.4	6.4	0.0	371.7
VT	631.6	633.6	0.0	13.5	164.4	0.0	99.0	2,697.5	183.8	0.0	4,422.1
WI	1,250.3	1,347.2	0.0	0.0	2,858.7	0.0	1,240.6	3,996.9	3,903.1	160.4	14,759.4
WV	130.8	47.2	249.4	443.8	9,173.9	0.0	173.7	1,681.5	17.4	0.0	11,917.7
	11,518.2	**16,849.5**	**2,148.1**	**2,854.8**	**48,455.0**	**619.2**	**9,201.4**	**45,115.8**	**17,846.2**	**624.5**	**155,300.9**

NOTE: Totals include Exotic species for WI - 2.2 and MI - 86.3.

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